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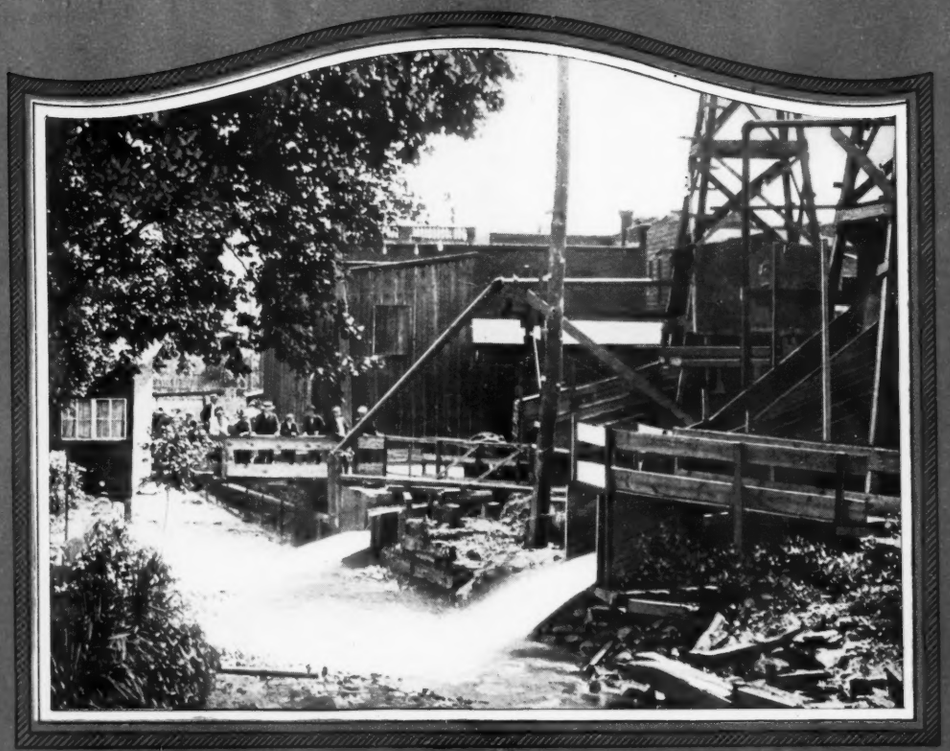

*AIR LIFTS DE-WATERING A FLOODED MINE AT THE RATE OF 16,000 GALLONS PER MINUTE*

**Drill Steel—Its Forging and Heat Treatment**
H. S. Brainerd

**Air Lift for De-Watering Mines**
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**San Francisco's Hetch Hetchy Water Supply**
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**Mining Sodium Nitrate in Chile**
Peter A. Raymond

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# *Great days for pneumatic hose buyers*

GOODRICH has put durability and flexibility into "COMMANDER" Pneumatic Hose.

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# Compressed Air Magazine

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VOL. XXVII, NO. XI

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NOVEMBER, 1922

# Drill Steel—Its Forging and Heat Treatment

## A Subject of Considerable Economic Importance About Which Too Little Is Commonly Known

By H. S. BRAINERD

**THE AIM of the present article is to disclose some of the distinctive characteristics of drill steel and to tell how it should be handled in the blacksmith shop when being forged, sharpened, etc. Much of this information will be new to many users of drill steel, and should prove valuable to a wide circle of our industrial readers.**

**When once the steel has reached the ultimate consumer or user, little heed is all too frequently given to the nature of the metal and the manner in which it has primarily been made fit for service. As a consequence, much valuable material is condemned or consigned to the scrap heap through ignorance of how to deal with the metal so as to keep it in a condition to do good work.**

STEEL IS NOT a single element or compound, but a complex artificial product composed of many elements held in the solid mass as a mechanical mixture of alloys and chemical compounds with the element, iron. In ordinary steel the essential constituents are iron and carbon. With these there are usually certain impurities such as phosphorus, sulphur and silicon which have not been entirely eliminated during the process of manufacture, as well as manganese—and perhaps other alloys such as nickel and chromium—which have been intentionally added for a definite purpose. All of these elements exert some influence in regard to the quality of the steel. Manganese present in an excessive amount causes the steel to harden intensively and renders it liable to crack in the hardening operation. It combines as a manganese sulphide with the sulphur, lessening the harmful influences of this element, which, in excessive quantities, forms iron sulphide and causes the steel to be "hot short" or to split and crack in forging. Steel with high phosphorus is very brittle; it makes steel "cold short" or extremely sensitive to failure by shock.

A good drill steel will have a carbon content of 0.80 to 0.90 per cent.; manganese from 0.15 to 0.30 per cent.; phosphorus and sulphur from 0.01 to 0.03 per cent.; and silicon from a trace to 0.30 per cent. It often happens that two drill steels, of practically identical analyses as far as ordinary elements are concerned, give such different service that we are forced to conclude that there are other factors than analysis which control ultimate quality. These factors are the method and the care taken in refining and the purity of the raw material.

Steel is composed of many individual crystals or grains of iron and of a carbide of iron built up in much the same way as is granite rock from the mineral feldspar, mica and quartz. These crystal constituents of steel are only visible with the aid of the microscope. When the steel is cast into ingots, the grains are comparatively very large, being later broken up into smaller grains by a combination of some mechanical work, such as forging, and a careful regulation of the forging temperature.

When a piece of steel is heated, the grains expand with increasing temperature similar to the usual expansion which bodies undergo when heated. When passing a certain temperature, called the critical temperature, the grains suffer an internal adjustment, and if cooled from this temperature, they will have at atmospheric temperature the smallest grain size possible for that steel. Upon heating the steel over the critical temperature, the grain size increases with the temperature up to a point where the grains are so large that we shall say the steel is overheated. Continued heating or long exposure to the furnace atmosphere at this temperature allows the gases to enter between the grains and to separate them. The steel is now burnt and fit only for scrap. Figure 1 shows a drill steel bit which has been burnt.

Steel becomes more plastic as the temperature increases, and, as a result, forging is usually carried on at a rather high temperature. The work or hammering which the steel receives reduces the grain size. The temperature at which forging stops is known as the finishing temperature. Above the critical temperature the hammering action causes the grains to flow over each other and the deformation or change in shape is caused by a change in the position of the grain. Hammering or forging below the critical temperature changes the shape of the grain itself and distorts it, setting up internal strains. The grains become harder and more brittle due to this cold work below the critical temperature and finally tiny checks or hair-line cracks develop.

Heating the steel for forging or hardening should be very carefully carried out. The atmosphere in the furnace should be controlled so that it is slightly reducing. If this precaution is neglected, or if the steels are exposed at a high temperature to an oxidizing atmosphere, the carbon in the exterior combines with the oxygen and passes off as a gas. This loss of carbon, called decarbonization, renders the steel incapable of being hardened on the surface. Many complaints that steel will not harden may be traced to this cause. This may be discovered by getting into the surface with a sharp corner of a file: the skin will file readily but underneath the steel will be file hard.

When decarbonized bits are hardened and put into service the soft outside flattens out and the steels are returned to the blacksmith as being too soft. He may redress and reharden them at a much higher temperature but the same thing happens again and finally the steel is rejected as defective. The remedy is to use a reducing flame in the furnace. In an oil fire, the flame will be oxidiz-

*Fig. 1.*

*Result of long exposure to high temperature.*

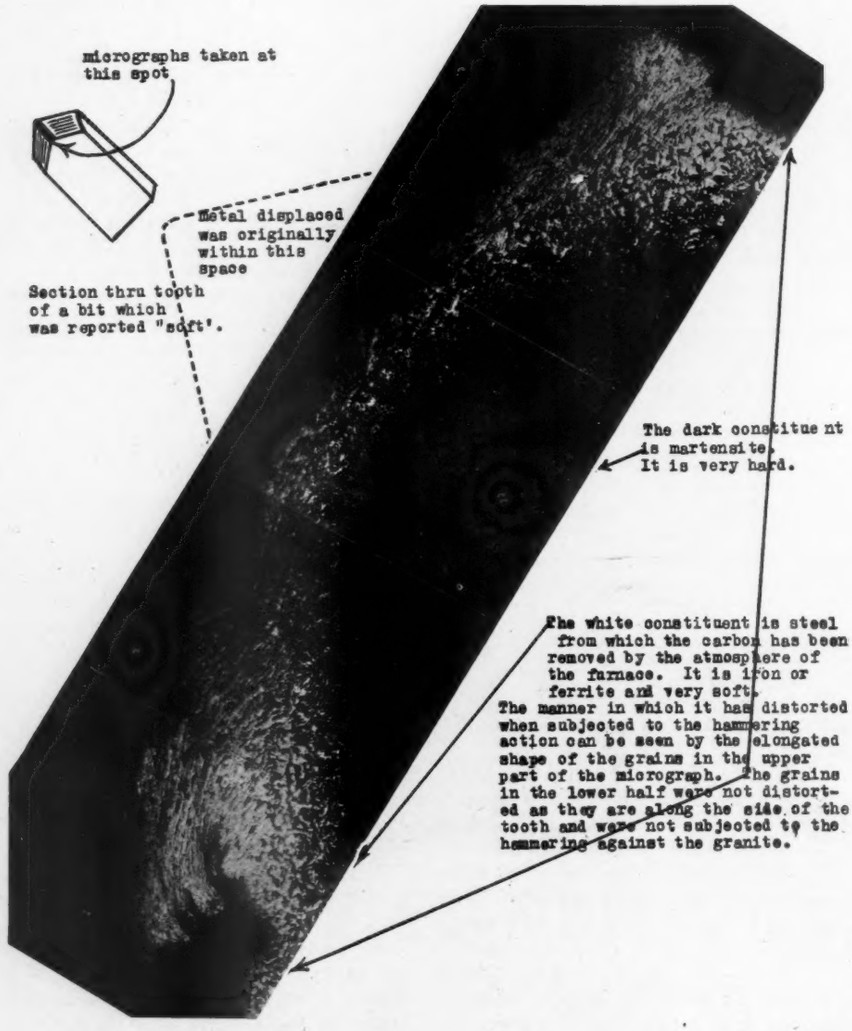

micrographs taken at this spot
Metal displaced was originally within this space
Section thru tooth of a bit which was reported "soft".
The dark constituent is martensite. It is very hard.
The white constituent is steel from which the carbon has been removed by the atmosphere of the furnace. It is iron or ferrite and very soft.
The manner in which it has distorted when subjected to the hammering action can be seen by the elongated shape of the grains in the upper part of the micrograph. The grains in the lower half were not distorted as they are along the side of the tooth and were not subjected to the hammering against the granite.

*Fig. 2.*

*Micrograph of cross-section through cutting edge of bit which had been decarbonized.*

ing or cutting if an excess of air is used, and reducing if an excess of oil is used. The former gives a light blue smoke, while the latter causes a black smoky flame. Fig. 2 (photographed through a microscope) shows a cross-section through the cutting edge of a bit. The metal which flattened out was decarbonized and the metal underneath this layer had hardened satisfactorily. Another remedy for this trouble is to file the decarbonized surface off each tooth after sharpening the steel and before hardening. Prevention is better than cure; and the steel should not be allowed to get into this condition.

The forming of drill steel bits and shanks requires that the steel be heated until it can be readily forged. High temperatures have a very injurious effect upon the steel. The following data was obtained in an effort to determine the relationship existing between the heating temperature used prior to sharpening "Jackhamer" drill steel bits and the drilling speed after the standard hardening treatment had been applied. Two bars of Ingersoll-Rand Swedish drill steel were made into standard "Jackhamer" steels, 24 inches long overall, with 1⅝-inch gage cross bits. One steel from each bar was then bitted at each end at the temperature shown in Fig. 3, the temperatures being measured with the Leeds & Northrup optical pyrometer. In no case was the temperature allowed to rise over that noted. The steels were bitted in a "Leyner" sharpener, type IR-50, and heated in a fuel-oil fired furnace. The standard heat treatment, which consisted of heating the bits to 1440 degrees Fahrenheit, and quenching in brine, was then given the steels. The actual drilling test was made with a BCR-430 "Jackhamer," using 70 pounds air pressure on hard granite rock. The condition of the bits after testing and the total inches drilled in three minutes are shown in Fig. 3. The steels which had been forged at 2500 degrees Fahrenheit were run for only one minute. It will be seen that the most satisfactory forging temperature is 1900 degrees Fahrenheit.

In addition to the internal adjustment which takes place upon heating as the critical temperature is reached, the steel undergoes a sudden contraction and then again expands with increasing temperature. This fact forms the basis of one of the rules of heat treatment which is, *heat slowly and evenly.* If this rule is not adhered to, parts of the steel, especially the outside, thin corners, or projections, may be heated to the critical temperature before the interior of the part is very hot. The hotter parts will be shrinking while the cooler parts expand, and severe stresses may be set up which will possibly cause failure. Another good rule to follow when subjecting steel to heat treatment is to quench on a rising heat and not on a falling heat. The differences in volume previously mentioned are greater when the inside of the piece is hotter and consequently expanded more than the outside which is cooler. This difference causes more stresses to be set up when the part is quenched; and if the difference is very great it may cause breakage in the quenching operation. The steel may be stressed almost to the breaking point, and a little additional shock, such as the first few blows of service, will cause it to fail. The steel is then

usually condemned as defective. Another reason for quenching on a rising heat is that the size of the grains is dependent upon the highest temperature of heating and not upon the temperature of quenching. If a part is heated to and quenched just above the critical temperature it will have a very fine grain size. If it is heated to a high temperature and allowed to cool slowly to just above the critical temperature, and quenched, it will have a coarse grain size corresponding to the high temperature. This condition is very undesirable.

A temperature is reached on heating and cooling steel which is called the critical temperature. At this temperature certain internal allotropic (change in state without a change in form) changes occur that are indicated by an absorption on heating and an evolution on cooling of heat, change in volume, and a change in magnetic properties. The change on cooling, or "Ar" critical point, occurs at a lower temperature than the change on heating, or "Ac" critical point, and cannot occur unless the piece has been heated beyond this "Ac" point. Drill steel of .85 per cent. carbon content has but one critical temperature for heating "Ac" 1.2.3 and on cooling "Ar" 3.2.1. The heating transformation occurs in a simple carbon steel without alloys at about 1340 to 1360 degrees Fahrenheit.

A chart showing an actual determination, by the differential method, of the transformation points of Ingersoll-Rand Swedish steel is illustrated in Fig. 4. The specimen from which this curve was made was hollow. A tiny platinum thermocouple was placed inside the hole and heated at a uniform rate in an electric furnace, the temperature being measured with a sensitive potentiometer. The evolutions and absorption of heat are shown by the deviation from a straight line of the heating and cooling curve.

The microstructure of .85 per cent. carbon steel in the annealed condition is a soft constituent called pearlite. The components of pearlite at ordinary temperatures are alpha ferrite (iron) and an iron carbide called cementite. Upon heating, the alpha ferrite changes to gamma ferrite as the critical temperature is passed. The carbide dissolves in the gamma ferrite and forms a solid solution called austenite. The change from alpha to gamma iron is accompanied by an absorption of heat, a loss of magnetism and a change in volume.

If the austentite (carbide in solution in gamma, non-magnetic iron) could be quenched instantaneously so that the critical change on cooling could not take place, the solid solution would be preserved at atmospheric temperature. The steel, however, cannot be quenched quickly enough to preserve this constituent, and other transitional constituents form according to the rapidity of the quenching and the degree of suppression of the "Ar" 3.2.1 cooling change. The transition constituent, martensite, will form if the steel is quenched very rapidly (in cold water or brine) from a temperature *sufficiently high enough above the critical temperature* so as to cause the rate of cooling through the critical temperature to be faster than the "critical rate" of cooling. If the rate of cooling through the critical range is slower than the "critical rate," the other softer transition con-

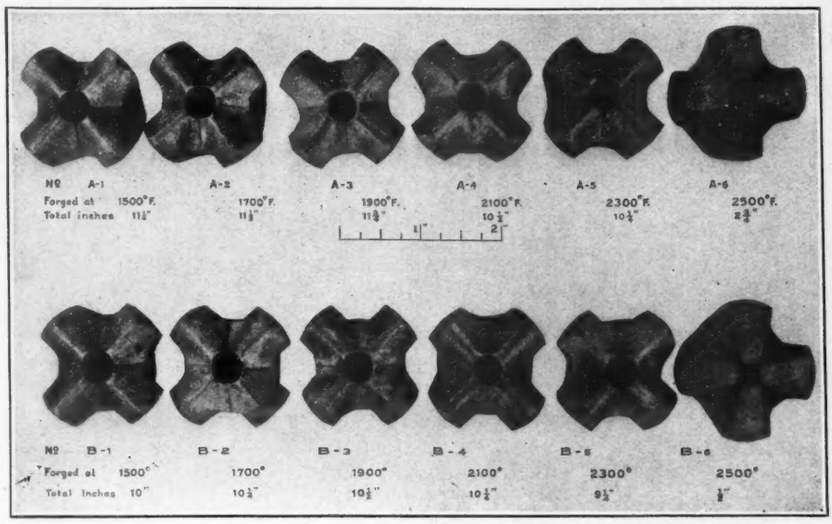



*Fig.* 3.

*Effect of forging temperature upon drilling speed of steels having similar heat treatment*

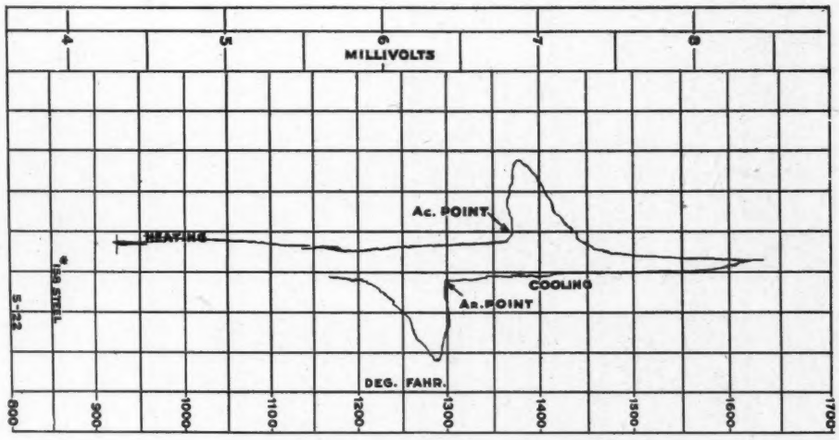



*Fig.* 4.

*Chart showing thermal transformation points of drill steel.*

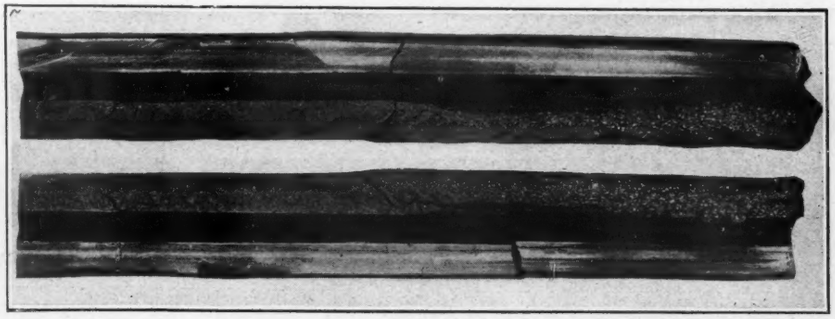


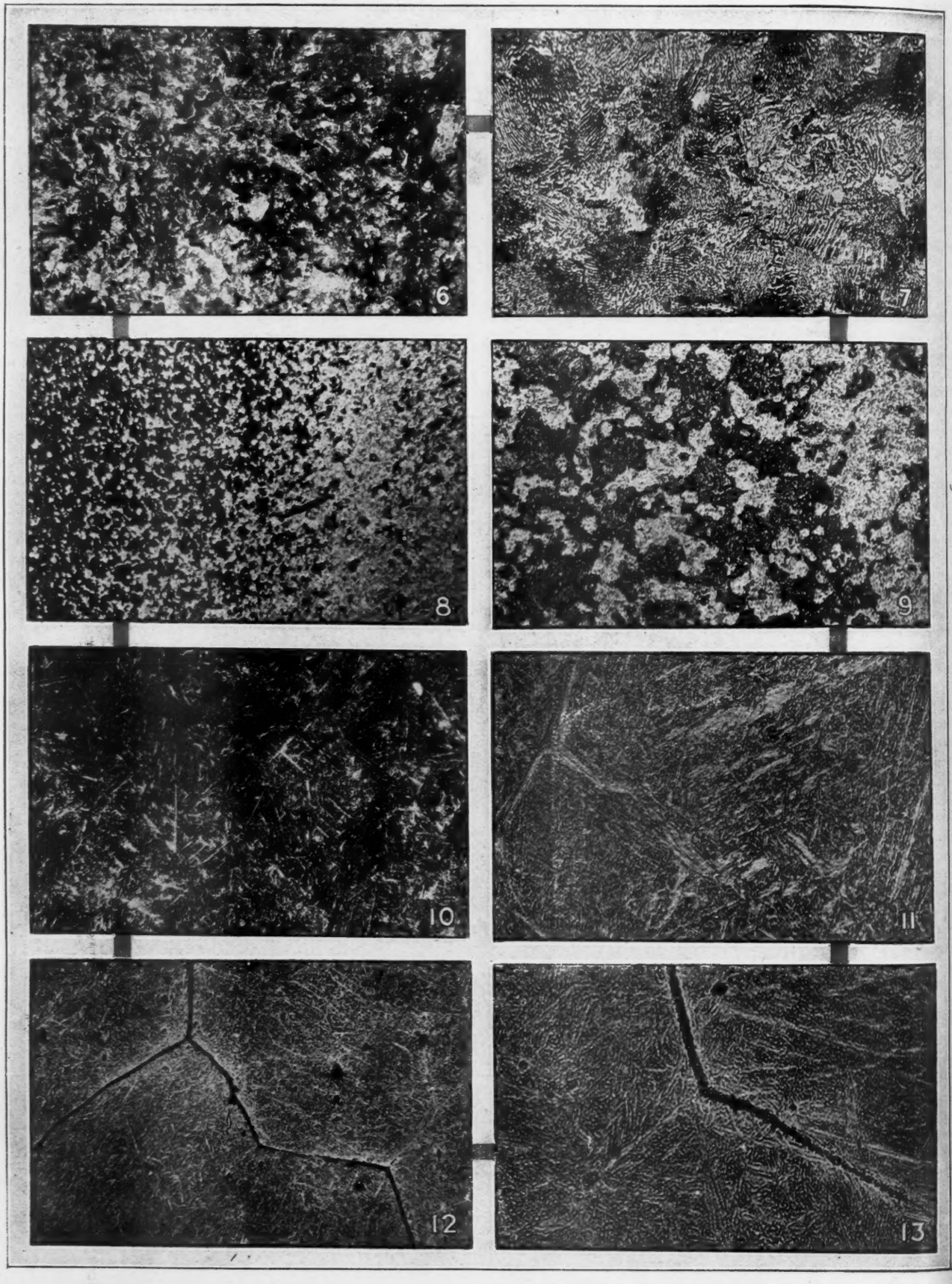
*Fig.* 5.

*Effect of quenching temperature upon the grain size.*

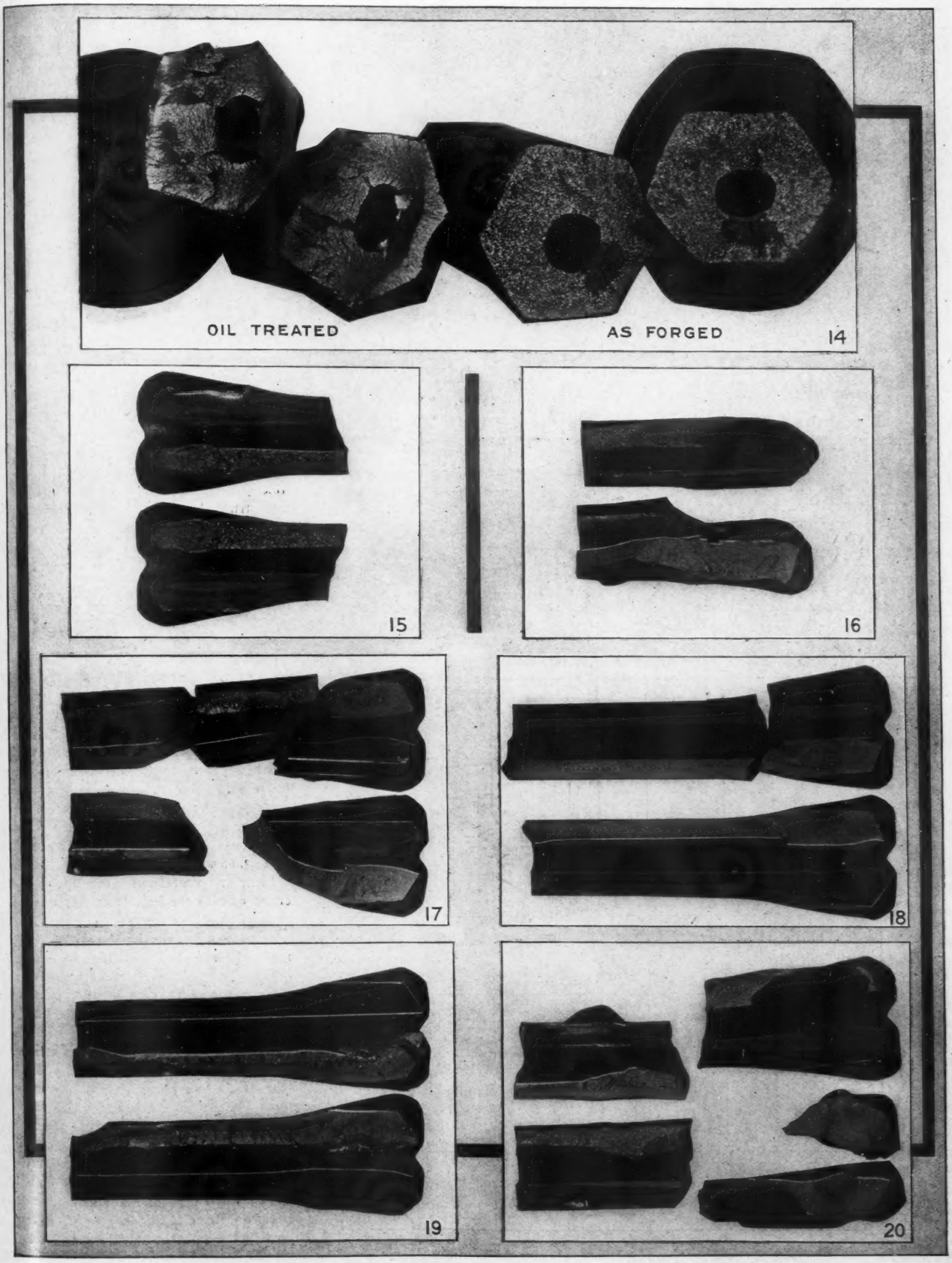
| * | | ** | *** | | | **** |
|---|---|---|---|---|---|---|
| *Black* 600°F | *Dull Red* 1200°F | *Cherry Red* 1400°F | *Orange* 1600°F | *Lemon Yellow* 1900°F | *White* 2200°F | *Scintillating White* 2600°F |

* —*Not heated. Location of Figure No.* 6 *and No.* 7.
** —*Quenched in critical range. Location of Figure No.* 8 *and No.* 9.
*** —*Quenched above critical range. Location of Figure No.* 10 *and No.* 11.
****—*Quenched at melting point. Location of Figure No.* 12 *and No.* 13.

## Structure of Drill Steel as Revealed by the Microscope



# Effects of Heat Treatment on Grain Structure of Steel



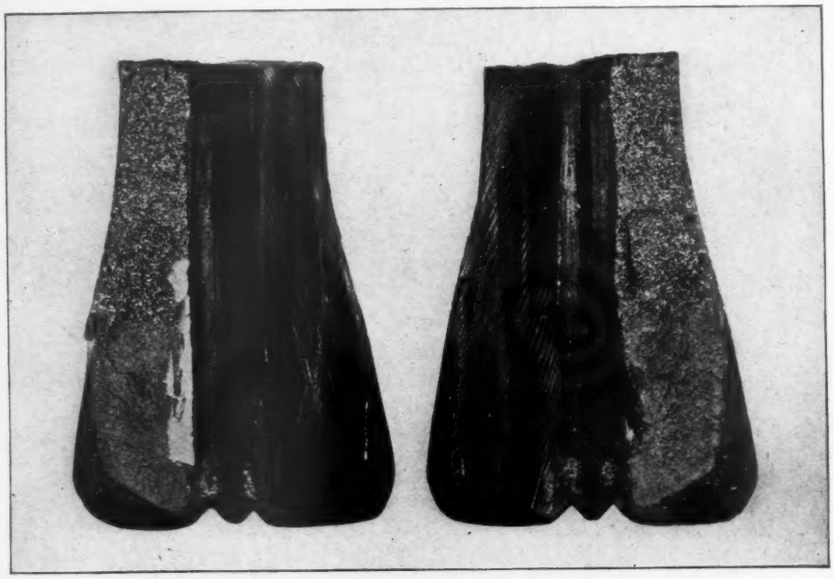


*Fig. 21.*

*Result of not overlapping the forging heat with the quenching heat.*

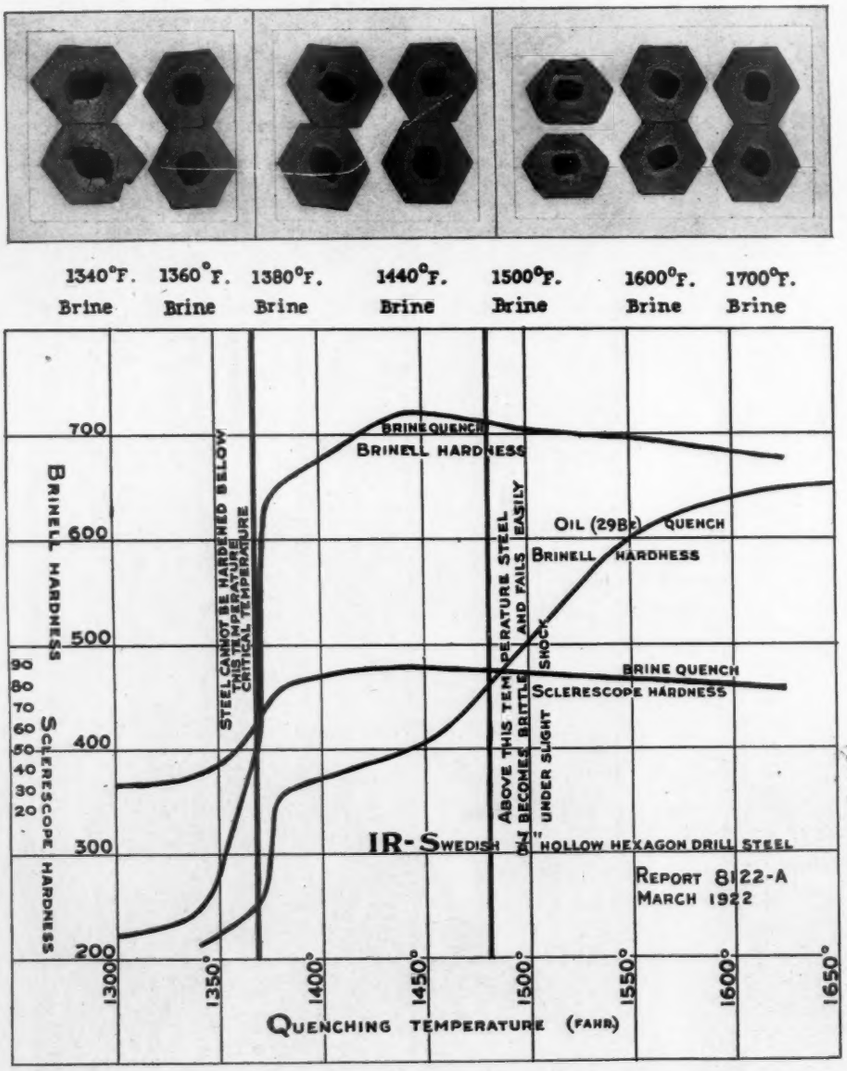



*Fig. 22.*

stituents, troostite or sorbite, will form. The correct temperature for hardening 0.85 per-cent. carbon drill steel in water, with martensite as the desired microconstituent, is not judged from the critical temperature or the loss in magnetism: they are factors which prescribe the temperature *above* which the steel must be heated. The actual temperature or degrees above the critical temperature is determined by the mass of the piece, its shape, the distance from the cooling bath, the cooling medium, etc.

The influence of the temperature upon the grain of steel is shown in Fig. 5 by a variation of the Metcalf test. A bar of ⅞-inch hollow hexagon drill steel was heated at one end to the melting temperature which is about 2700 degrees Fahrenheit, while the other end was at atmospheric temperature and the intermediate regions at proportionate temperatures. The piece was quenched in cold water, split lengthwise with a very thin emery wheel, and broken for fracture. The grain size produced by any temperature can be readily seen. Examination was also made of the structure under a microscope. This metallographic examination shows the internal structure after etching with picric acid in alcohol. Fig. 6, at 90 diameters, shows an average structure of pearlite with some thin fibers of slag and oxide. Fig. 7, at a magnification of 500 diameters, shows the pearlite to be distinctly lamellar. Fig. 8, at 90 diameters, shows the structure of that part of the steel which was quenched while in the critical range. The dark etching areas are martensite or martensite and troostite, while the lighter material is in the nature of sorbite. Fig. 9, at 500 diameters, shows the martensitic structure in the dark etching areas. Fig. 10 consists entirely of coarse martensite. It is shown in detail in Fig. 11, at 500 diameters. This grain is overheated but can be restored by reheating to a temperature slightly over the critical temperature and then by cooling in air or oil. Fig. 12 shows very coarse martensite with intergranular cracks due to quenching action and temperature. Steel which has been heated to this stage cannot be restored because the cohesion between the grains has been destroyed. The round black spots in the structure are due to the melting of the non-metallic inclusions. The details of Fig. 12 are shown in Fig. 13, at 500 diameters.

Little or no attention is ever given by the average user to the heat treatment of drill steel. It is believed that considerable economy may be effected in the mine by the proper heat treatment of drill steel, inasmuch as the influence of the proper treatment of both shanks and bits upon the life of the piston drill parts and drill steels cannot be overestimated. The hardness obtained by quenching drill steel from a suitable temperature in water, brine, alkaline water, and rain water will vary but little. If the volume of the quenching medium is small and a large number of steels are quenched in it, a different condition arises, as the hardness obtained depends upon the cooling powers of the quenching medium. The cooling power of water falls off with a rise in temperature of the water, and over 100 degrees Fahrenheit it is seriously affected. Brine at this temperature has approximately the same cooling power as at a much lower temperature. Almost any kind of water

will satisfactorily harden drill steel provided it is used in sufficient volume at a satisfactory temperature.

Such oils as the No. 2 Soluble Oil from the E. F. Houghton Co., and the Matchless Quenching Oil of the Atlantic Refining Co., are very satisfactory for quenching purposes. These oils have a good quenching speed, do not have an objectionable odor, do not decompose or depreciate with use, and have the same quenching speed at all temperatures up to 250 degrees Fahrenheit. The oils have a specific gravity of about 29 degrees Be., a flash point of 350 degrees Fahrenheit and a fire test of 370 degrees Fahrenheit. It is very necessary that the right grade of oil be used for quenching purposes. Oils which are too heavy require too high a quenching temperature to obtain the correct hardening, while oils which are too thin make the steel too hard and brittle.

After continuous use, due to deposit of burnt slag and oil from the steel, the quenching oil will in time become dirty. This can be remedied in the following manner. Place water amounting to one-third the volume of the oil in the bottom of a separate tank, adding the dirty oil without any attempt at stirring. This cleaning tank should be provided with a spigot in the bottom and a spigot six inches above. Allow to stand for 48 hours at a temperature of 160 degrees to 180 degrees Fahrenheit. The clean oil will be at the top of the tank, the water will settle to the bottom, and between the good oil and the water there should be a sludge. Draw off the water from the bottom spigot and allow the sludge to fall below the top spigot. Draw off clean oil from the top spigot. Care should be taken not to leave any water in the mixture.

Drill shanks should be hardened at 1470 degrees Fahrenheit in quenching oil such as has been described above. This temperature is recommended for the ⅞-inch hollow hexagon steel, but for shanks with a larger section a little higher temperature should be used to take care of the increased section of the steel. The benefit derived from quenching the shanks in oil may be seen in Fig. 14. The coarse character of the fracture of one of the shanks has been induced by the forging heat, and this shank broke with very little deformation. The other oil-treated shank has a fine fracture, is very tough, and suffered considerable deformation before it broke.

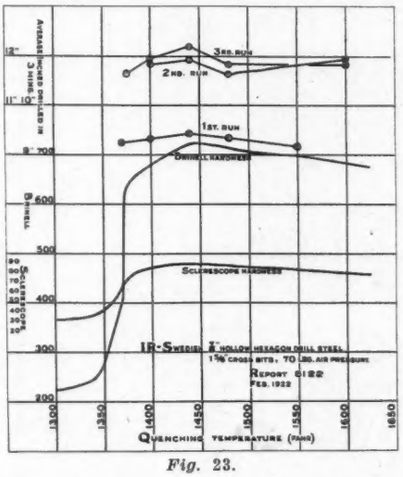



*Fig.* 23.

There are many methods of hardening drill steel bits, and the following data shows a comparison of six methods. The comparatively high forging temperature, 1900 degrees Fahrenheit, which is required in order that a bit may be formed easily, quickly and economically, gives a coarse grain, which is weak, and this should be removed by heat treatment. Fig. 15 shows the appearance of a fracture of a bit which has been heated to 1440 degrees Fahrenheit, for ¾-inch from the teeth, and quenched all over in brine. The fine-grained structure near the teeth has been produced by the hardening operation and is very hard. The coarse grain in the remainder of the piece has been caused by the forging temperature and has not been affected by the hardening operation. Fig. 16 shows a bit which has been heated to 1600 degrees Fahrenheit for ¾-inch from the teeth and quenched all over in brine. The coarse grain structure near the teeth has been produced by the hardening operation. It is not as hard as that shown in Fig. 15, and is much more brittle and non-resistant to shock. The coarse grain in the remainder of the piece is due to the same cause as that in Fig. 15, that is, the forging temperature. The high hardening temperature has caused the bit to crack. This crack was not visible before fracturing the bit.

Fig. 17 shows a bit which has been heated to 1440 degrees Fahrenheit for the same distance from the teeth that it was heated for forging and quenched all over in brine. The reheating has entirely destroyed the coarse grain left by forging. On the extreme left the grain of the original bar is seen. The remainder of the steel is encased in a fine-grained, thoroughly refined zone of very hard metal. A thin core of toughened grain structure is seen around the hole. This is not sufficient to prevent the steel from breaking back of the bit; and this method of heat treatment is not recommended. Fig. 18 shows a bit which has been heated to 1600 degrees Fahrenheit in a manner similar to that shown in Fig. 17. The high heat has caused the steel to harden through all sections: leaving a coarse crystalline grain which is very hard and brittle. The resistance to failure of this structure is very small, and the specimen very easily separated into two pieces. The embrittling effect of this higher temperature can be seen by comparing this fracture with that of Fig. 17. The latter, although very hard, had to be broken several times to obtain the full length of fracture. This method of heat treatment is not recommended.

Fig. 19 shows a bit that was heated to 1440 degrees Fahrenheit, at the same distance that it was heated for forging, and only the teeth quenched in brine. The reheating has entirely destroyed the coarse grain left by forging and replaced it with a fine, tough grain structure. The toughness of the structure can be seen by the manner in which it broke. The teeth have been given maximum hardness but resistance to service stresses is also at a maximum. This method of hardening is recommended. Fig. 20 shows a bit which was heated to 1600 degrees Fahrenheit in the same manner as the bit shown in Fig. 19. The extremely coarse grain left by forging has been destroyed and replaced by a grain which is sufficiently coarse to be unsuitable. Note the smooth manner in which this piece broke, comparing it with the "tough" appearance of Fig. 19. The high heat has caused the bit to fracture and has produced a coarse-grained, brittle, hardened zone extremely liable to fracture. This temperature is too high for satisfactory results.

The heat treatment recommended for drill steel bits about 1⅝ inches in diameter is to heat

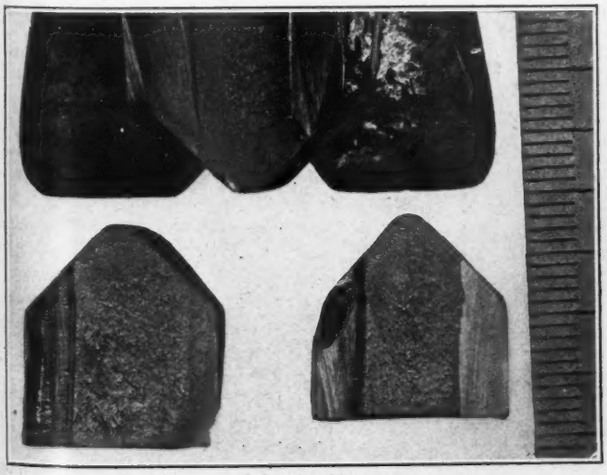


*Fig.* 24.

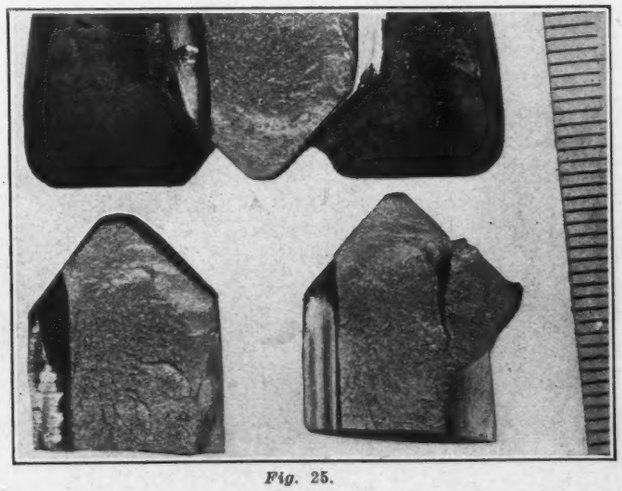
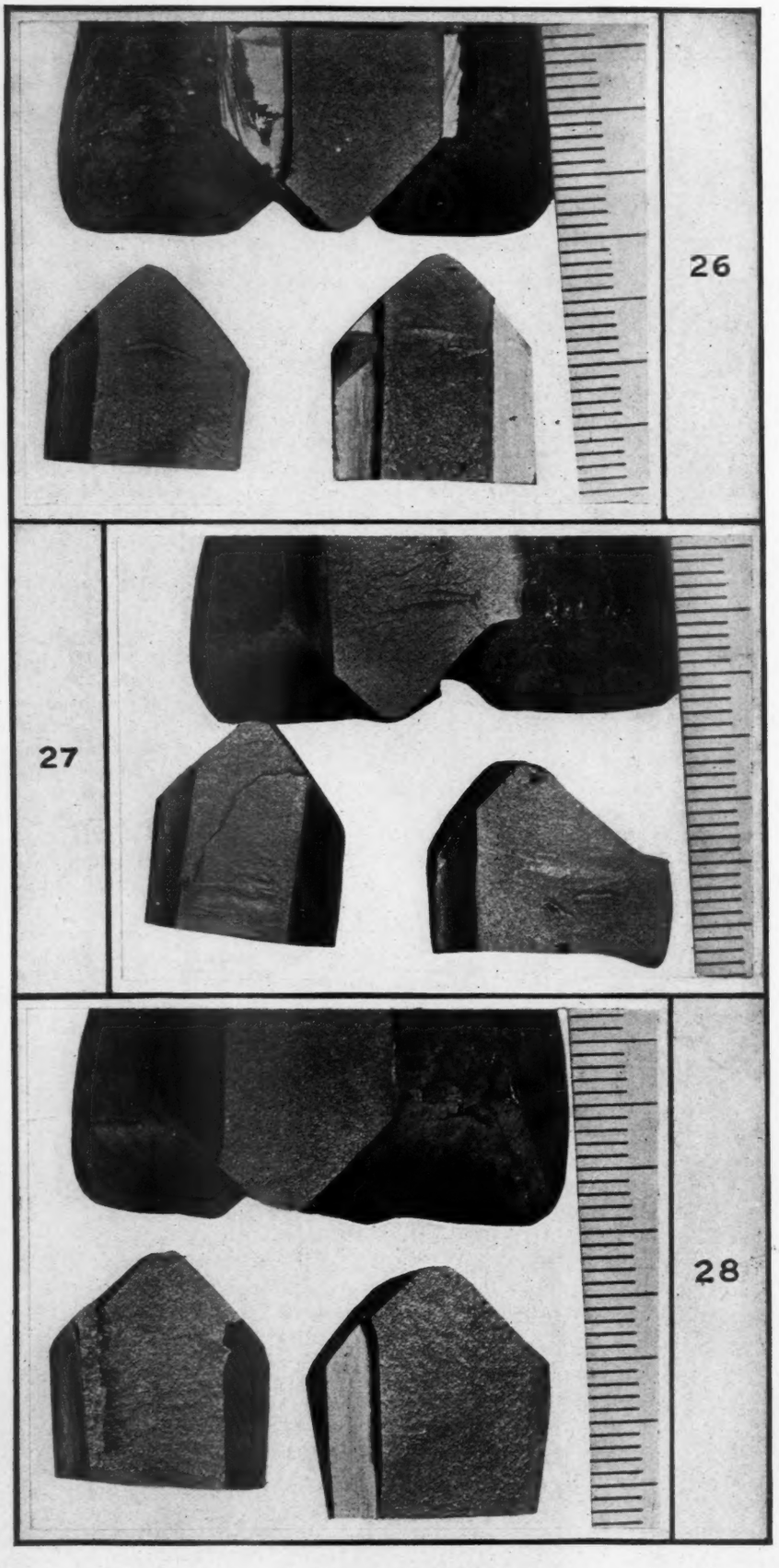


*Fig.* 25.




to 1440 degrees Fahrenheit for the same distance back that they were heated for forging and to quench the teeth only in water or brine. When the entire steel becomes black it may then be quenched, all over, in water with safety.

As the size of the bit increases, short heating for hardening has a greater tendency to cause failure. Fig. 21 shows a bit received from a property where a serious steel breakage was occurring. The examination of the fracture indicates a condition similar to that shown in Fig. 15. The breakage was due to the weakening effect of the large grain size left by the high forging heat and which had not been removed by heat treatment. The breakage ceased when the bits were correctly heat-treated.

It is generally supposed that the higher the temperature used for quenching the harder the steel will become. This is incorrect, and Fig. 22 shows the relation of the hardening temperature to the hardness for pieces of ⅞-inch hexagon hollow quenched in brine. The hardness has been measured by two different types of apparatus. In the Brinell method, a hardened steel ball 10 mm. in diameter is pressed into the specimen with a load of 3000 kg. for a half minute. The diameter of the resulting impression forms the basis for hardness determination. In the scleroscope method, a tiny diamond-pointed hammer is dropped about ten inches upon the object and the height of the rebound is estimated upon an arbitrary scale.

Fig. 22 also shows the fractures of ⅞-inch hollow hexagon drill steel hardened in brine at several temperatures. These photographs may be used for a guide in the estimation of the quenching temperature used. If the blacksmith will harden a small piece of ⅞-inch hollow hexagon at the temperature usually used and the steel shows a refined structure throughout the entire cross-section, the heat is too high and should be lowered until the fracture shows a hardened outer shell and a tough inner core. It will be noted that the holes in the steel shown in the photograph are not round. This has been caused by the break and the position in which they were photographed.

A curve for the oil quench shows that at high temperatures a ⅞-inch hexagon hollow shank will become quite hard. The extreme end of the shank facing the striking end of the piston becomes harder than the body of the shank. The curve has been plotted from the hardness values obtained on this end so that they may be duly compared with the hardness of the piston.

The effect of the quenching temperature upon the hardness and the drilling speed, in granite, of ⅞-inch hexagon hollow steel, with a 1⅝-inch cross bit, is shown in Fig. 23. The granite block used on the first run was appreciably harder than that used on the second and third runs. Each run was made with a BCR-43 "Jackhamer," using 70-pound air pressure. The steels were heated for five inches of their length in a lead bath and only the teeth quenched in brine. Six steels were quenched from each temperature and were run only three minutes before they were rebitted. The points plotted for the steels hardened from 1600 degrees Fahrenheit, for the second and third runs, represent only four steels each, as two of the six on each

run spalled off several teeth due to the brittleness caused by the high quenching temperature.

Figs. 24 to 28, inclusive, show the fractures of hardened bits which have been heat-treated at five different temperatures. The bit in Fig. 24, which was hardened at 1375 degrees Fahrenheit, shows a hardened zone which is thin and not fully refined. The low heat has prevented the quenching action from penetrating to the center of the unhardened inside or core and refining it. The unrefined portion seems to be crystalline in appearance. Hardening from this temperature will give erratic results, and a large portion of the steels will be soft. When hardened at 1400 degrees Fahrenheit, the zone of hardening shows considerably deeper in Fig. 25 than when hardened at 1375 degrees Fahrenheit, and is well refined. The higher heat has allowed the quenching action to penetrate to the center and refine it. An illustration of a bit hardened at 1440 degrees Fahrenheit is shown in Fig. 26. The hardened zone is deep and nicely refined while the core has received the benefit of the quenching action and is refined as well. Fig. 27 shows what may be expected when hardening is carried on at 1480 degrees Fahrenheit. The hardened zone is deep and the grain is rather coarse, the core also being hardened by the intense quenching action sets up by the high temperature. A bit hardened at 1600 degrees Fahrenheit is shown in Fig. 28. The high temperature has caused the entire section to harden through. The fracture is coarsely crystalline and the steel is very brittle.

Most drill steel failures are induced either by fatigue or by incorrect treatment and abuses in the blacksmith shop. Fatigue failures are occasioned by physical defects in the material. There is a certain brand of Swedish steel on the market which is as near perfect as it is possible to make steel. When proper care is exercised in the forging and the hardening it will give very superior results, but when treated carelessly it is not as good as a poor steel very carefully handled.

## THE "MAKINGS" OF PAPER

PROBABLY few of us have an adequate appreciation of the complications of paper manufacture or of the range of materials required. Upon the authority of a prominent paper manufacturer, the following commodities are needed in the production of 100 pounds of common wood-print paper: Wood, 13.4 cu. ft.; sulphur, 12.7 lbs.; limestone, 17.5 lbs.; kerosene, 5.7 oz.; bleaching powder, 14.3 lbs.; rosin, 3 lbs.; soda, 0.515 lb.; alum, 4.2 lbs.; color, 1.8 oz.; coal, 320 lbs.; iron sulphate, 0.79 oz.; copper sulphate, 0.19 oz.; lime, 3.17 oz.; and 7,500 gals. of chemically treated and filtered water.

It is given out as an item of news that the Province of Quebec has bought from the United States Radium Corporation one gram of radium for $100,000. As we figure it, that would be at the rate of $2,835,000 per ounce, avoirdupois, or $90,720,000,000 per short ton. Don't ask us what it would be in *marks*.

## UNIQUE HORSESHOE DAM AT LOST RIVER

TAKING THE FORM of an extended horseshoe with the toe upstream, a dam recently completed on Lost River, by the Reclamation Service of the United States Department of Interior, justifies the description of being unique in construction and eccentric in its performances. Its shape is responsible for discharging the overflow of water from the reservoir into the interior of the horseshoe-like structure on the installment plan, so to speak. Its surplus energy is dissipated in opposing currents and whirlpools before the water departs from the solid concrete architecture, whence it leaves placidly.

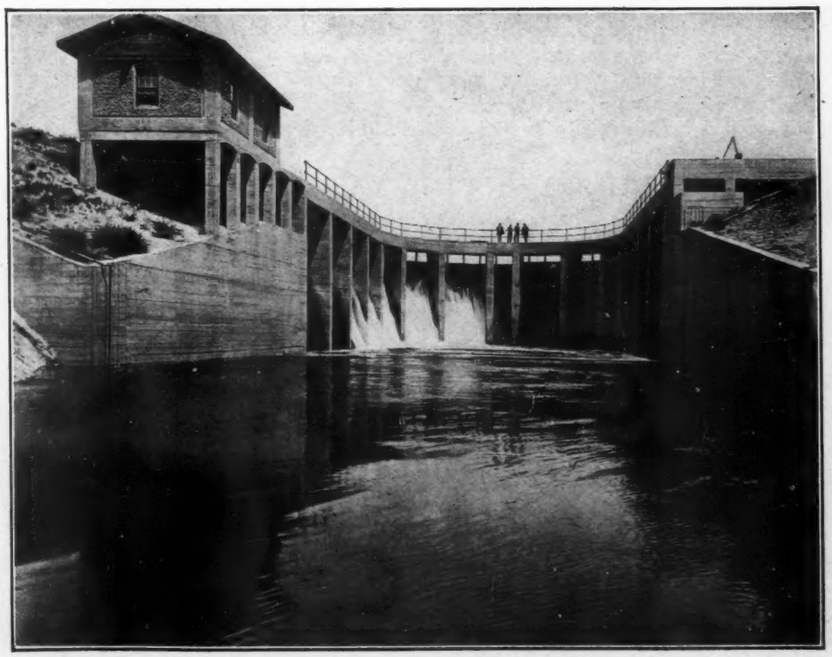
This novel diversion dam, located near Wilson's bridge in Oregon, owes its departure from conventional design to necessity—the foster parent of ingenious plans and contrivances. It was essential to raise the water nearly to the elevation of the flood plane in order to render the diversion channel feasible. Yet, to recognize another condition quite as insistent, the water could not be permitted to even barely exceed the same level in periods of floods lest an overflow do untoward damage to valuable lands in the valley above the diversion channel. This ground possesses an extremely flat slope of water surface. The imagination of the engineer was unbridled with the result that a long overflow weir with movable crest, affording adequate discharge of the water at the permissible head, became a reality. Hence the dam was fashioned along the lines of an elongated horseshoe.

A weir of equal length across the valley would have involved considerable excavation to extend the structure downward to a suitable foundation. Likewise, this alternative would have necessitated expensive negotiations for directing the overflow harmlessly to the natural channel below. The diversion passageway has a capacity of 420 second-feet. Since its completion the diversion of flood waters, excepting peaks of deluges, has been accomplished. Thus, its reclaiming powers have assisted in restoring to usefulness the bed of Tule Lake, embracing an area of 30,000 acres.

The Lost River dam has a run-off, below the reservoir, into the stream from which the concrete structure derives its name, varying from 25,000 to 120,000 acre-feet. The interior pool of the dam is 110 feet long and 60 feet wide. The structure is located 34 feet above the bed of the river, and earth embankments link it to higher ground on each side. Structurally, this barrier for impounding water contains 5,000 cubic yards of concrete and 13,140 cubic yards of earth embankment. The diversion channel, stretching itself for a distance of eight miles, courses west through Lost River and Klamath Valleys to Klamath River. The excavation involved the removal of 467,400 cubic yards of material.

H. D. Newell, manager of the Klamath project in Oregon and in California, in his last report to the Reclamation Service, which embraced observations for the month of February, 1922, says: "Throughout February the ground was covered with snow from six to ten inches deep. The diversion canal was operated during the entire month diverting water from Lost River to the Klamath River." Thus, the Reclamation Service, although departing from conventional design in the construction of a horseshoe-like dam, has added another triumph to its series of successes in reclaiming the lands of the West.

In a small Wisconsin town there is a factory in which aluminum lip-stick containers are manufactured. The polishing of the containers filled the air with the dust of the metal and no one, apparently, had thought of the danger. A spark from a piece of wire, which was carried to the suction fan, caused an explosion and six girls were killed.



*Lost River horseshoe dam at Klamath, Ore.*

# Air Lift for De-Watering Mines

## Large Capacity Air Compressors, Up to 2,000 and 3,000 Feet Displacement, Used for Pumping Water in Anthracite Coal Mines

By HERBERT AXFORD

THE ANTHRACITE coal mining district is subject, from time to time, to what is known in the region as "drown outs," caused by heavy rains; sudden thaws in winter when the surface is covered with snow; rivers and creeks overflowing their banks, etc. As a consequence water pours into the mine workings through countless fissures and cracks at a more rapid rate than the total pumping machinery of the colliery can handle, resulting either in the pumps being submerged or having to recede, as the water rises in the mines. The latter procedure is commonly impracticable and in many cases is impossible because of the large pumping units employed. These "drown outs" may occur only once in several years, but, even so, they entail great financial loss to the operators owing to damage to equipment and to the halting of activities, as no coal can be mined during these periods.

On account of the more general use of "Jackhamers" and other air-driven mining tools in the anthracite mines, air compressors of large capacities will be found at a great many collieries, compressors of 2,000 and 3,000 feet displacement not being uncommon.

It has often been urged that pumping water by the air lift method be more generally considered wherever a large air compressor is installed, which, of necessity, stands idle when no coal is being cut. It is not necessarily advocated that the air lift be used for every-day pumping duty, but, instead, to deal with exceptionally heavy inflows of water or for emergency service. All that would be required in such cases would be a suitable bore hole with the proper submergence and the incidental pipe, valves, and fittings. This pumping equipment could then be started at a moment's notice, and would never be drowned out no matter how much water flowed into the mines.

If the collieries from Carbondale to Jermyn, Pa., of the northern anthracite coal fields had been equipped with these emergency air lift pumping plants, there is no doubt that the damage done by the flooding of the mines, due to the heavy rains of last June, would have been considerably alleviated if not entirely prevented. On Saturday, June 3rd, an extremely heavy rain storm occurred in northeastern Pennsylvania, amounting almost to a so-called "cloud burst" at Crystal Lake, filling up and overflowing all the creek and stream banks, washing away bridges, and overturning buildings. The water poured into many mine openings and eventually found its way to the basin of the Jermyn mine of the Hudson Coal Company at Jermyn.

The pumping equipment at this colliery, although liberal, judged by the usual requirements, and believed to have ample reserve capacity, proved entirely inadequate. The pumps had to be abandoned, in fact the pumpmen had none too much time to save themselves. A week later, just when the Hudson Coal Company had installed emergency pumps to recover these station pumps, a second rain storm hit the region. This was almost as severe as the first one, resulting in the emergency pumps also being drowned out. Before the month of June was ended this region was deluged by a third and a fourth heavy rain storm, which, though not quite as violent as the first two, poured large quantities of water into the already deluged mines. In consequence, an area of substantially 450 acres was submerged—the depth of the workings being approximately 260 feet, and the water rising to within about 70 feet of the surface.

The question then arose as to the cheapest, best, and most expeditious way of de-watering this mine. Electric-driven centrifugal pumps had been procured and were being installed at all the available places; but even though the total pumping capacity of these units was about 22,000 gallons per minute, this was not sufficient.

There were two 24-inch diameter bore holes reaching from the surface to the pump-room inside the mine. As one of these bore holes formed the discharge or column line of the submerged steam pumps, the remaining hole was disconnected at the bottom and not then in service. It was suggested that an air pipe be run down this hole; that an air compressor be obtained; and that an improvised air lift be installed. This bore hole had a depth of 240 feet—extending from the surface to the roof of the mine, and had an inside diameter of 36 inches from the surface to the rock, a distance of 60 feet, and an inside diameter of 24 inches through the rock. A curve, Fig. 5, was submitted to the officials of the Hudson Coal Company showing the estimated discharge to be expected from this hole for each 1,000-cubic-foot air compressor capacity. Suggestions were made as to suitable foot piece, etc., and it was recommended that 60 feet of 26-inch pipe be inserted in the 36-inch pipe so as to make the hole 24 inches in diameter in the lower section, tapering to 26 inches. This, however, was not done. Water in the bore hole then stood at an elevation of 890. It was explained that owing to lack of submergence the air lift would be inoperative with this arrangement of piping when the water fell to an elevation of about 810. This was not deemed objectionable, for as soon as the water reached this elevation it would then enable the Hudson Coal Company

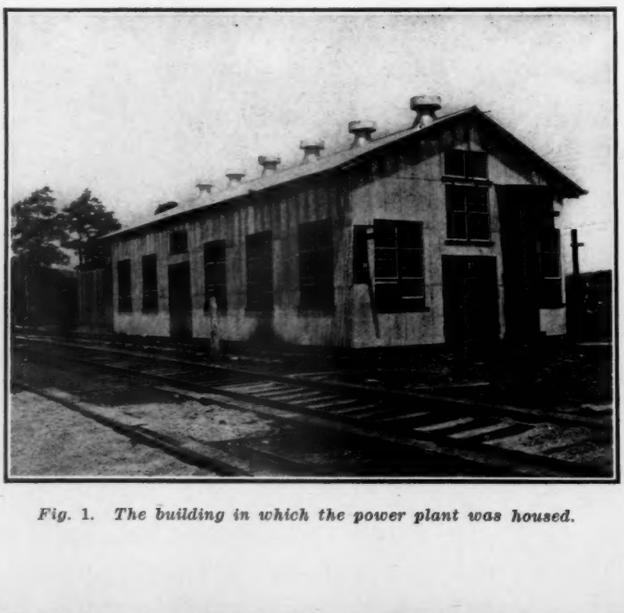


*Fig. 1. The building in which the power plant was housed.*

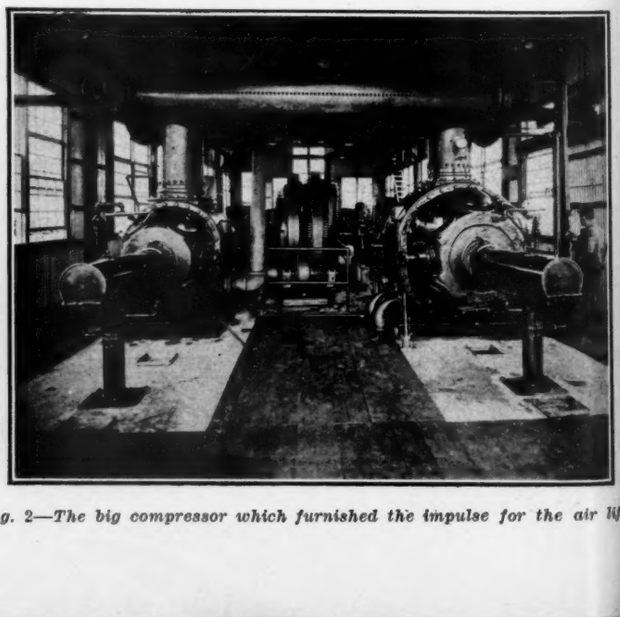


*Fig. 2—The big compressor which furnished the impulse for the air lift.*

to recover some of their submerged pumping machinery and also permit them to resume operations in the upper veins, in case the suspension was settled.

An Ingersoll-Rand "PRE-2" direct-connected, synchronous motor-driven air compressor, which had been used on war work, was purchased. It had a 40-inch diameter low pressure air cylinder, a 25½-inch high pressure air cylinder, had a 30-inch stroke, and was driven by a General Electric Company 3-phase, 60-cycle, 4,000-volt, 1,020 H.P., 138½ R.P.M. synchronous motor. As the Hudson Coal Company generated 25-cycle current, a frequency-changing set had also to be installed. This the company was able to procure on short notice. Foundations, which were immediately begun, were completed upon the arrival of the machinery at Jermyn on July 25th. On July 31st, the machinery was started up and housed over. Fig. 2, shows the air compressor as erected. In the background can be discerned the direct-connected exciter of the frequency-changing set. Fig. 1, illustrates the outside view of the completed building. Remarkably efficient work was done by the Hudson Coal Company's engineering and construction corps in erecting, installing, wiring, piping, and housing a machine of this size in less than one week's time. That the unit has been running continuously up to date is sufficient proof that the job was well done.

An 8-inch wrought iron air pipe was run from the compressor to the bore hole a distance of about 1,000 feet. This pipe was reduced to six inches at the bore hole, and a 6-inch pipe was run down inside the 24-inch bore hole to what was thought to be within five feet of the bottom. The foot piece consisted of a bronze casting drilled with 730 one-quarter inch holes pointing upward at an angle of 45 degrees. This casting had four ribs or guide plates cast on its bottom so as to center the air pipe in the bore hole.

When the piping was completed and air was turned into the bore hole the water came out with great force, rising about twenty feet into the air above the 36-inch pipe. The discharge was intermittent: lasting from six to ten seconds every 35 to 40 seconds. This intermittent discharge was caused entirely by the sudden enlargement of the bore hole from 24 inches to 36 inches in diameter. It was estimated that 7,000 gallons per minute were being discharged. The air pressure at commencement of discharge varied from 60 to 65 pounds and immediately dropped to from 40 to 45 pounds, when the discharge ceased. Then the pressure was again built up to from 60 to 65 pounds and another large volume of water gushed from the hole.

When it was found that only one-half of the air compressor capacity was being used it was decided to utilize the second hole, which, as before mentioned, was connected to the discharge of a submerged steam pump. As water, in order to flow into this bore hole, would have to pass through the pump with its strainer, suction and discharge valves, it was proposed to blow out the bottom of this hole. This was done by setting off a couple of sticks of dynamite. What damage was done by this ex-

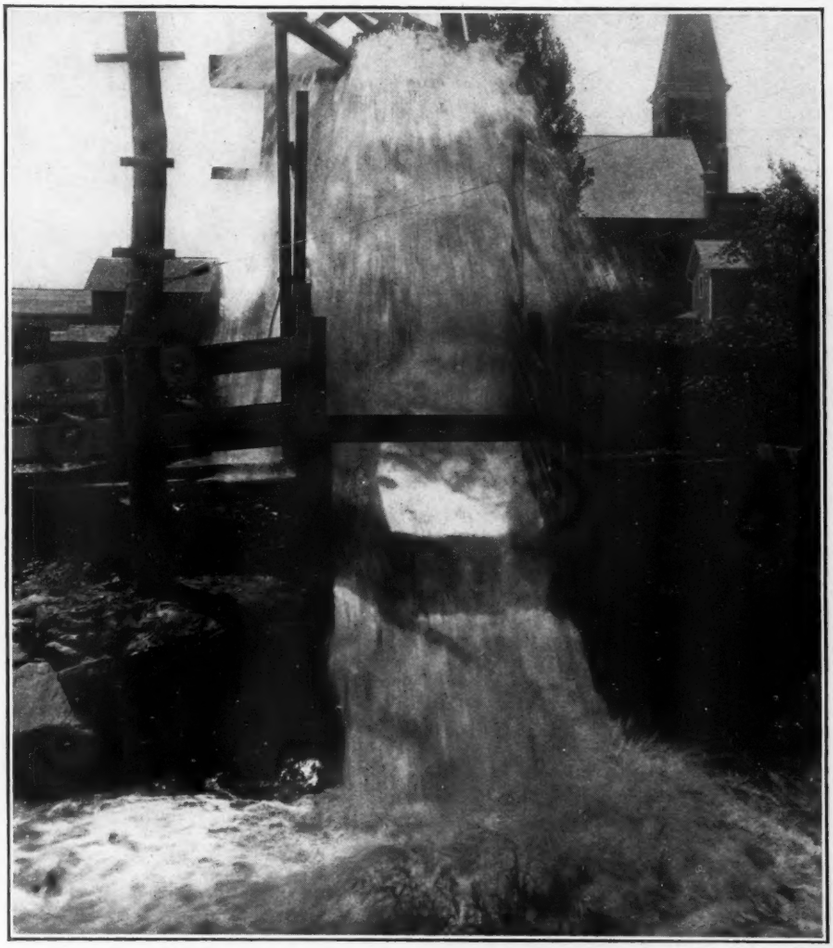


*Fig. 3. A close-up of the discharge of one of the air lifts, showing the force with which the water was ejected.*

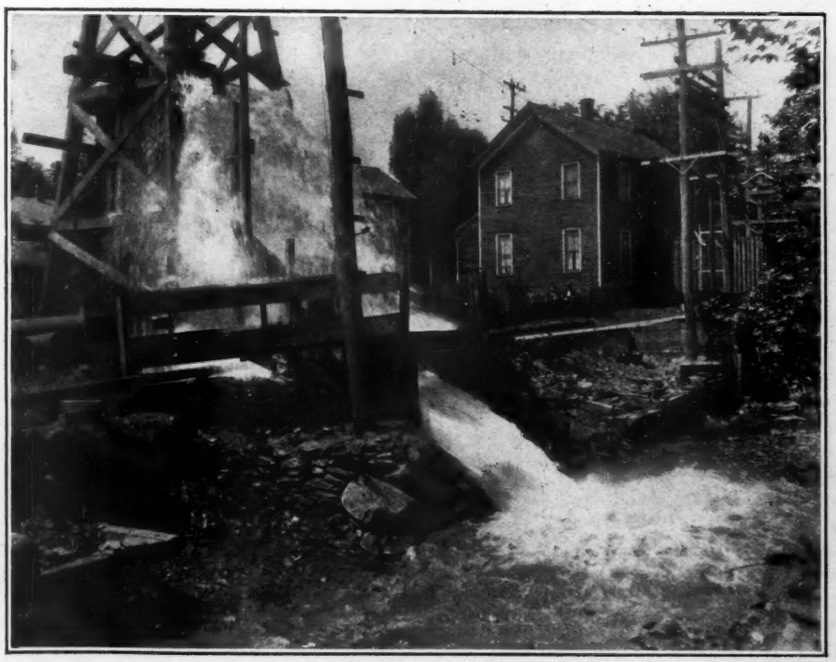


*Fig. 4. When in full operation the two air lifts discharged quite 16,000 gallons of water each minute.*

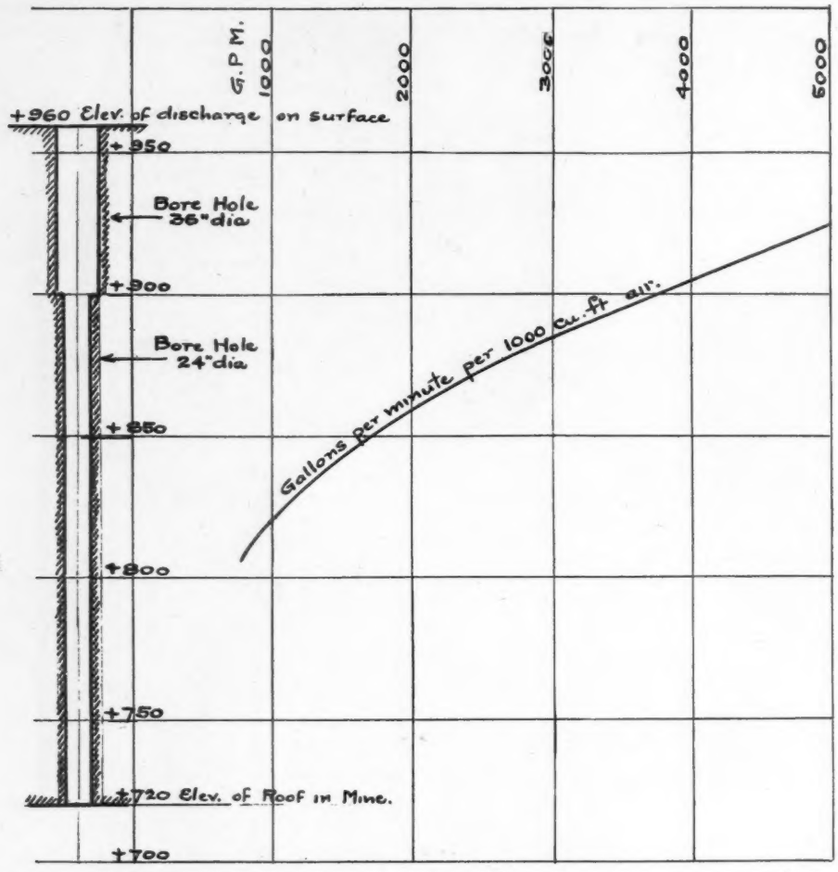



*Fig. 5. Curve showing estimated discharge in gallons per minute per 1000 cubic feet piston displacement of air compressor, assuming 85 per cent. volumetric efficiency of compressor.*

plosion to the pump and its piping inside the mine will be interesting to note when the mine is opened again. A 5-inch wrought iron pipe was then run from the 8-inch main line down this second hole to within what was judged to be about five feet from the bottom of the bore hole. Instead of making a foot piece, a number of holes about ¾-inch in diameter was burned at the bottom of the last length of pipe by an acetylene torch, and the end of the pipe was plugged. Upon turning the air into this second hole, which was of the same general construction as the first, it operated with the same intermittent discharge, but the amount of water expelled appeared to be slightly greater. At that time it was estimated that the bore holes were exhausting a total of from 12,000 to 14,000 gallons per minute, and they were utilizing the full capacity of the air compressor.

Figs. 3 and 4, illustrate the well in action, and indicate clearly the spectacular effect produced.

It is to be regretted that a continuous, steady flow could not be obtained; but it is certain that the intermittent discharge from the wells, both synchronizing perfectly and discharging every 35 to 40 seconds as regularly as clockwork, was more interesting to watch and seemed to be more of a wonder to the general public than would have been the case had the wells gushed regularly.

Before the wells were put in operation, and with about 22,000 gallons being pumped out of the mine, the water was lowered at the rate of something like nine inches in 24 hours. But with the aid of the air lifts, the wells increased this to sixteen inches every 24 hours.

The wells had one great advantage over the pumps. As the water receded the pumps had to be lowered, which took time, and headway was lost in the struggle against the water, whereas the air lifts kept right on working.

It should be clearly understood that air lifts cannot be broadly recommended for continuous service in mine pumping, because the efficiency of the air lift does not compare favorably, from the power utilization standpoint, with that of high-duty mechanical pumps wherever these agencies can be employed to advantage. But for emergency pumping, such as the de-watering of mines, auxiliary pumping to take care of sudden increase of flow, and for stand-by units, this method of handling water is believed to be well worthy of greater consideration. In many instances, the air lift will prove to be the cheapest medium, taking into account its utility and its freedom from all up-keep charges.

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Contrary to an impression prevailing widely, all ports in Alaska south of the Aleutian Islands are open to navigation every day in the year, and it seems that through Seward and Anchorage freight may reach all points along the line of the Alaskan Railway to Fairbanks without interruption.

## NEW WORK ON THE CATSKILL WATER SUPPLY SYSTEM

THE DRIVING of the Shandaken tunnel and the building of the Gilboa dam in connection with the Schoharie development of the Catskill water supply system are being prosecuted with satisfactory dispatch by the contractors who have these great engineering tasks in hand.

The excavation of the tunnel is more than 95 per cent. completed, but the headings at four points are not yet holed through. A slight amount of excavating has still to be done at the portal where water conditions have hampered the contractors. This situation, however, has been neutralized by the cutting of a temporary drainage tunnel which carries the in-pouring water to a sump. At the present rate of progress, all excavational work should be concluded during the approaching December or sometime in January of 1923.

Fully 20 per cent. of the lining of the tunnel has been finished. The concrete for this purpose is being placed by a novel pneumatic system, and the means employed are effective in saving time and in doing the work more satisfactorily than it can be done by hand in similar circumstances.

For the sake of those interested in details, the following data is furnished covering activities up to the end of September—the latest particulars available. Out of a total length of 95,391.6 feet, the excavating of 90,925 feet has been completed. Of the lining, 23,172 feet of arch and 28,370 feet of side wall have been placed.

The Gilboa dam is now 37 per cent. finished, and the work is going forward without a hitch. Rock excavation is substantially finished. It was originally estimated that this phase of the undertaking would require the removal of 60,000 cubic yards of rock. As a matter of fact, however, the job has called for the taking out of 65,931 cubic yards of rock. Of earth excavation, the contract specifies the removal of 275,000 cubic yards, and 146,353 cubic yards has been disposed of up to date. There will be 500,000 cubic yards of embanking, and 70,345 cubic yards of this is now in position. It it estimated that 370,000 cubic yards of cyclopean masonry will be worked into the dam, and of this volume 123,925 cubic yards is in place.

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## PNEUMATIC GRAIN ELEVATORS FOR GLASGOW

UNTIL quite recently Glasgow had only the old-fashioned bucket elevators for handling grain. Even a fine modern plant at Meadowside, opened a few weeks before the outbreak of the war, was served by elevators of this type. Now, however, an up-to-date pneumatic suction elevator has been installed. It has a capacity of 100 tons of grain per hour.

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The Cleveland Museum of Natural History, which is to be conducted on the same general lines as the Smithsonian Institute in Washington, D. C., has requested the American Mining Congress to advise its members that space will be available to them in the Museum for mineral exhibits.

# San Francisco's Hetch Hetchy Water Supply

## PART IV*

## Details of the Aqueduct Tunnels and of the Mechanical Facilities Employed in Their Construction

By NELSON A. ECKART and LESLIE W. STOCKER

IN THIS FINAL installment of our account of the Hetch Hetchy undertaking, compressed air's part in speeding up the execution of the great task is brought to a climax. Anyone familiar with engineering jobs of this magnitude and general character will readily appreciate how much penumatic tools and other air-driven mechanisms contribute not only to rapid progress but also to better work.

The tunnels of the Mountain Division, between Early Intake and Priest, now under construction, total 18.3 miles in length. For about six miles from Early Intake west, the formation is very hard, close-grained granodiorite, which can be relied upon to stand indefinitely without support, and for that reason this particular tunnel section, Fig. 1, is to remain unlined. The excavation within the neat line is 6.21 cubic yards per linear foot; and the overbreak averages about 1.25 cubic yards per linear foot, making a gross excavation of about 7.5 cubic yards.

The remaining twelve miles is mostly through a slate formation in which the strike is generally less than 45 degrees from the direction of the tunnel and the dip is very steep. The rock, on the whole, stands well, only occasional short sections requiring timbering; but it is blocky and seamy, necessitating lining with concrete. Here the excavation within the neat line is 3.91 cubic yards per linear foot, and the concrete 0.65 cubic yard. The average overbreak in the different headings varies from about 0.8 to 1.1 cubic yards per linear foot.

The lined and the unlined sections are both designed to carry 620 cubic feet of water per second with a loss of head, due to the frictional resistance to flow, of 1.2 feet per 1,000 feet of tunnel. The entire tunnel aqueduct will operate under a hydrostatic pressure head of from twenty to 70 feet.

*The first installment of the Hetch Hetchy series appeared in the August issue.

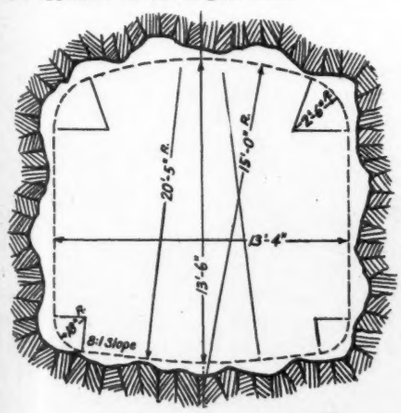



*Fig. 1. Cross-section of standard unlined tunnel.*

The grade rate in the tunnels is 1.55 feet per 1,000 feet. In pressure tunnels, just as in pressure pipes, the hydraulic gradient is to a large extent independent of the tunnel gradient. Where consideration of drainage, during construction, makes it advisable, some of the tunnels to be built later will actually rise in the direction in which the water is to flow.

Seven adits, two shafts, and a river canyon divide the 18.3 miles of tunnel into eleven sections, the longest being 4.5 miles. Only two of the adits, however, are used for opening headings. The other five are to serve for ventilation and, in some instances, for dumping. Thus the 18.3 miles is virtually divided into only six sections. Excavation is now being prosecuted in ten headings.

The tunnels are being constructed under a cost-plus-fee contract by the Construction Company of North America, of which Charles C. Tinkler is president and A. J. Cleary is consulting engineer, both of San Francisco. The contractor's bid fixed guaranteed maximum unit costs, which, for the principal items, are as follows:

| | |
|---|---|
| Lined tunnels, not including permanent timbering, per linear foot | $78.95 to $82.08 |
| Unlined tunnels, per linear foot | 66.87 to 67.84 |
| Shaft, per foot of depth, including concrete lining | 330.00 |
| Concrete lining to be placed in tunnels excavated prior to this contract | 16.50 |
| Permanent timbering, per linear foot of tunnel | 25.00 |

The total length excavated to July 24, 1922, was 71,474 feet, or 13.5 miles.

In all headings, the entire face is drilled and shot in a single round. In the slate formation, 25 holes are ordinarily drilled to a round—six cut holes, six relievers, ten side and back holes, and three lifters. The vertical "V" cut is used. In the cut holes 11-foot steel is utilized, and in the others 9-foot steel. The round is drilled in about four hours after setting up, and pulls seven to eight feet. A crew consists of three drillers, three helpers, and five muckers.

In the granite the round consists of from 42 to 50 holes. In a 45-hole round the diamond cut of eight holes is used, and six first relievers, nine second relievers, seventeen back and side holes, and five lifters. For the cut holes, 15-foot steel is used and 13-foot steel for the others. This round is drilled in nine to ten hours, and makes an advance of from eleven to twelve feet. In some ground, however, it is necessary to limit these rounds to seven feet. The drill crew works on a call basis; the second crew drilling the lifters and shooting the round. Four drillers, four helpers, and five muckers make up the crew. The 42-hole round, as shown in Fig. 3, is resorted to in two headings where the formation is very hard, close-grained granodiorite.

Electric, delay-action exploders, fired from the 440-volt power circuit, are employed. After shooting a round, the muck is cleared from the upper half of the face, and the first set-up of the drills for the next round is made. The drills are supported on horizontal bars with 30-inch and 36-inch column arms, two set-ups being made. In the smaller headings, the first is made on top of the muck pile, and in the larger headings this is done from a scaffold, over the muck, which is supported by bars inserted in holes drilled in the side walls when drilling the round. Mucking and drilling then proceed together. Mucking out a round by means of the Myers-Whaley machine takes from three to four hours for the smaller headings, and about eight hours for a 12-foot round in the larger ones. The second set-up of the drills is made for the lifters after removing the muck. For blasting in slate, 40 per cent. dynamite is used, and for breaking up granite, 60 per cent. dynamite. In each case the quantity is close to eight pounds per cubic yard, measured in place. In the ten headings now being driven, the total progress averages more than 160 feet per day.

The establishment of a bonus system was a great stimulus to progress. Basic rates of progress per shift were fixed for each heading, and a bonus is given for each foot of progress in excess of the monthly basic rate. All men laboring in the tunnel receive the full bonus, while those employed outside, whose work varies little whether progress is rapid or not, get half of the rate paid the inside men.

The heading of Priest Tunnel passes through varying formations, and for several months has been in altered slate and schist. The record progress for one month's work in the aqueduct

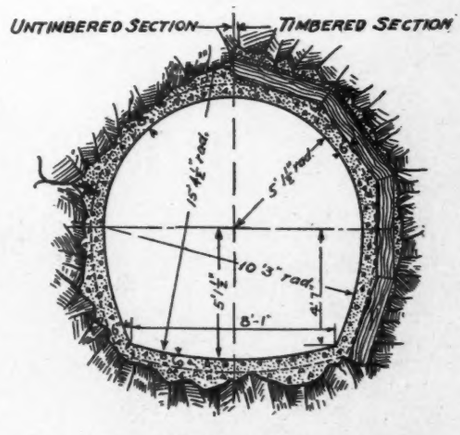



*Fig. 2. Cross-section of standard lined tunnel.*

## TUNNEL PROGRESS FOR AUGUST, 1921

| Heading | Tunnel Section | Character of Rock | Number of Holes | Superintendent | Shifts Worked | Progress Feet Per Month | Total Progress to Date |
|---|---|---|---|---|---|---|---|
| | | monolithic | 45 | | | | |
| Intake ..... | 13 ft. 8 in. | granite | 48 | Johnson | 62 | 273 | 7,179 |
| South Fork | | | | | | | |
| East ..... | 13 " 8 " | " | 48 | Peterson | 67 | 424 | 7,020 |
| West ..... | 13 " 8 " | " | 45 | " | 69 | 477 | 2,795 |
| Adit 5-6 | | | | | | | |
| East ..... | 13 " 8 " | granodiorite | 38 | Gallagher | 62 | 300 | 1,017 |
| West ..... | 13 " 8 " | diorite | 34 | " | 93 | 406 | 1,070 |
| Big Creek | | | | | | | |
| East ..... | 11 " 3 " | " | 25 | Fowler | 62 | 414 | 3,125 |
| West ..... | 11 " 3 " | " | 25 | " | 62 | 420 | 4,117 |
| Priest ..... | 11 " 3 " | altered slate | 25 | Hickman | 93 | 776 | 11,130 |
| | | | | | | 3,490 | 37,453 |

Number of holes represents the number of holes necessary to blast the round.
Progress at Priest is, we believe, a record for the United States in hard-rock tunneling.

C. C. TINKLER,
Pres. and Gen. Mgr.

tunnels was made in this heading in August, 1921, and totaled 776 feet. This is the American record for tunnels of this class! Three shifts, drilling 25 holes per round, are worked in the section. The Priest and Big Creek headings are being excavated under a sub-contract by A. C. Dennis and Frederick Wilson. Mr. Dennis' work on the Rogers Pass tunnel of the Canadian Pacific Railway won much favorable comment.

The service required of machinery used in tunneling is so severe that only the most rugged and least complicated types are suitable. In choosing equipment for the Hetch Hetchy job the primary consideration was reliability, and, next, simplicity and economy in operation, maintenance, and repair. Cheapness in first cost, while important, was relegated to third place.

Careful attention to the selection and upkeep of the equipment has so far eliminated serious delays due to breakdowns. The importance of continuous work will be appreciated when it is realized that the Moccasin Creek power plant will begin operations upon the completion of the tunnels and that the value of the power to be generated at that plant will be in the neighborhood of $5,000 per day.

Some of the principal items of mechanical equipment employed at the various points in tunneling operations are as follows:

As far as economical and practicable, units have been standardized so that like parts are interchangeable.

The air compressors on the job are of the cross-compound, belt-driven type, with short belt and tightener. Each compressor has its own driving motor. All but two have a displacement capacity of about 670 cubic feet of free air per minute to 100 pounds gage pressure, and are driven by 100-horse-power motors. Ordinarily the capacity of one compressor is sufficient for the needs of a single heading: the second or third compressor at a plant from which one or two headings, respectively, are driven, being a spare. These extra compressors have a displacement capacity of about 500 cubic feet of free air per minute to 100 pounds gage pressure, and are driven by 75-horse-power motors. One compressor at Second Garrotte shaft is steam driven. This is a precaution in case the electric power supply should be interrupted, in which contingency the water can be kept from flooding the shaft by air-operated pumps.

Blowers for ventilation are all of the positive pressure type, with a displacement capacity of 4,500 to 4,700 cubic feet of air per minute at a pressure of about twenty ounces, and are belt-driven by 25-horse-power motors. Each blower is fitted with a "four-gate system" for reversing the air current in the pipe to either "blow" or "exhaust." The ventilating pipe, in all but three faces, is of 24-inch diameter, 16-gage, riveted steel, and is in 19-foot, 7-inch lengths made with butt ends and joined with bolted cinch bands. The pipe and bands are protected against corrosion by dipping them in hot asphalt after riveting. In the Priest heading, the steel air pipe extends for a distance of 7,100 feet from the portal into the tunnel while the remainder of the piping to the face consists of 14-inch diameter, machine-banded, wood staves. A positive pressure blower, operated by a direct-connected compressed air engine, is installed near the face, and this forces the gases and the impure air outward through the pipe. The blower is worked for but fifteen to twenty minutes after each shot. The 14-inch wood-stave pipe is also used in the Big Creek headings where the blowers at the surface are operated for about half an hour after shooting.

The wood-stave pipe has the advantage of much greater strength to resist blows than the sheet-steel pipe and can, therefore, be kept closer to the face without fear of damage by flying rock. Being smaller, it is more conveniently handled, and occupies less space in the tunnel; but much more power is required to force a given quantity of air through it. The cost of the wood pipe and of the steel pipe, delivered at the tunnel camps, is, respectively, about $1.10 and $1.50 per foot, including connections.

At the four tunnel camps, other than Big Creek and Priest, the method of ventilation is to exhaust for about 30 to 45 minutes after shooting, and then to blow air through the pipe, one or more times during each shift, for an hour or two: the theory being that the shorter period of exhausting quickly removes the greater part of the smoke and fumes from the heading, while the pressure system supplies pure air to the men at work. This system is, no doubt, best where the length of tunnel is beyond the limit at which it is possible to completely change the air by blowing in the interval available between two blasting rounds.

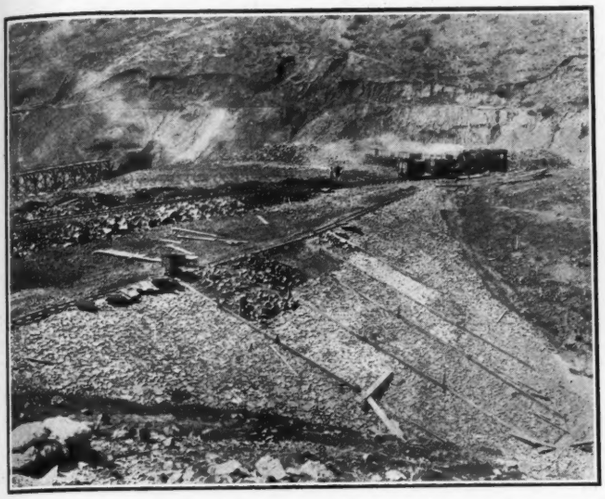
Most of the drills used on the project are "Leyner" drifters, model No. 248. For tunnel work they are mounted on horizontal bars. In heating drills to be resharpened or reshanked, oil furnaces were found to be superior to coal-burning forges as they give more uniform heat and are cleaner and more compact. They are also more economical—the cost of oil used per shift being at present not much more than half that of coal for an equivalent coal-burning forge. A No. 3 Ingersoll-Rand, oil-burning furnace satisfactorily serves one drill sharpening machine.

Mucking machines have entirely superseded hand mucking on the Hetch Hetchy undertaking. Following the standardization principle, Myers-Whaley electrically-driven mucking machines are used throughout, except at Big Creek shaft. There the shaft compartments are too small to permit the larger parts of the Myers-Whaley machine to be lowered through them. The Hoar underground shovel, a small air-operated machine, was chosen for Big Creek.

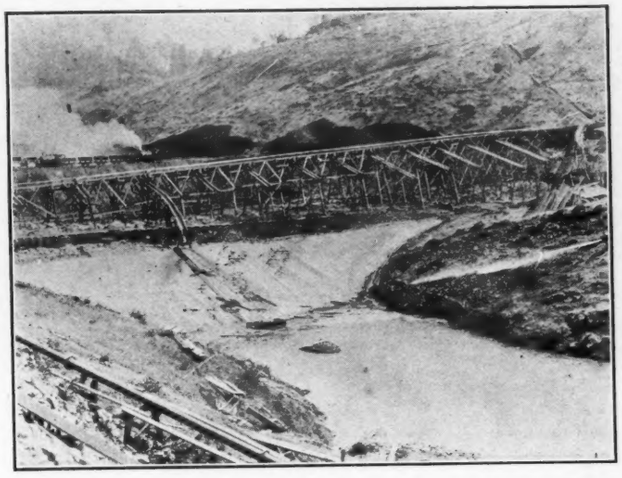
Each camp is equipped with two or three mucking machines, according to whether one or two headings are being driven. The extra

| | Early Intake | South Fork | Adit 5-6 | Adit 8-9 | Big Creek Shaft | Second Garrote Shaft | Priest |
|---|---|---|---|---|---|---|---|
| Number of headings being driven..... | 1 | 2 | 2 | 2 | 2 | shaft | 1 |
| Air compressors, | | | | | | | |
| Electric-motor-driven ..... | 2 | 3 | 3 | 3 | 3 | 2 | 2 |
| Steam-engine-driven ..... | | | | | | 1 | |
| Positive blowers for ventilation, | | | | | | | |
| Electric-motor-driven ..... | 1 | 2 | 2 | 2 | 2 | 2 | 1 |
| Air-engine-driven ..... | | | | | | | |
| Drill sharpening machines, | | | | | | | |
| Pneumatic ..... | 1 | 2 | 2 | 2 | 2 | 1 | 1 |
| Heating furnaces for drills, | | | | | | | |
| Oil burning ..... | 1 | 2 | 2 | 2 | 2 | 1 | 1 |
| Mucking machines ..... | 2 | 3 | 3 | 3 | 2 | | 2 |
| Electric locomotives, | | | | | | | |
| Four-ton ..... | 1 | 1 | | | 2 | | 4 |
| Five-ton ..... | 2 | 3 | 3 | 3 | | | |

# Various Aspects of the Building of Priest Dam

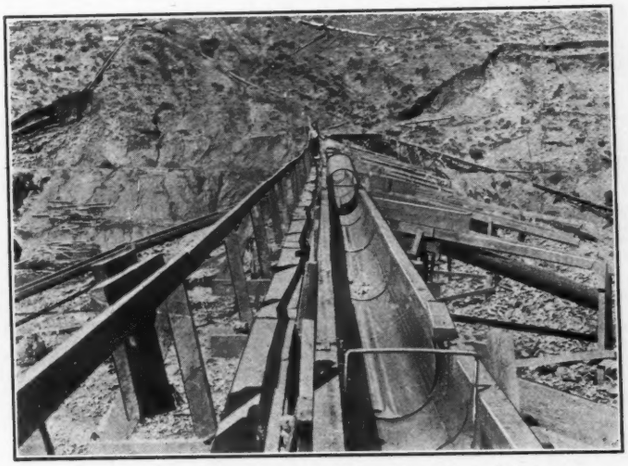


*Upstream embankment, with riprap pavement, prior to the beginning of hydraulic sluicing.*

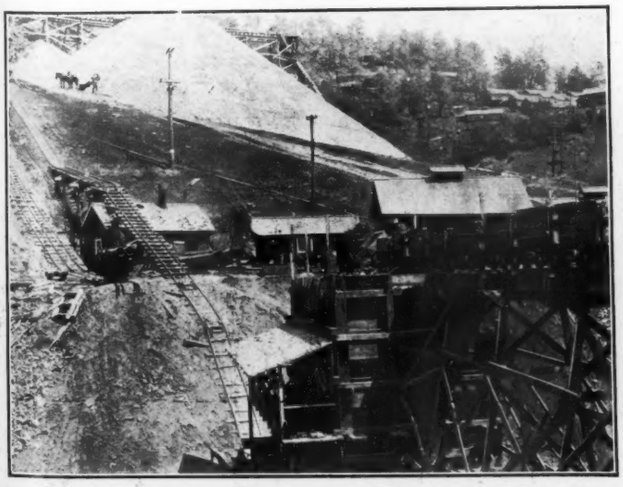


*General view of the dam looking downstream, showing flume employed in carrying sluiced material.*

*Washing down material from hillside to form the hydraulic fill of the upstream embankment.*

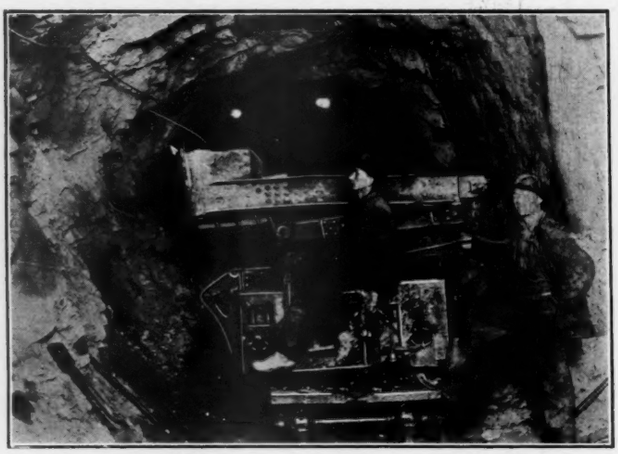


*Close view of the flume in which sluiced material was conveyed in making hydraulic fill.*

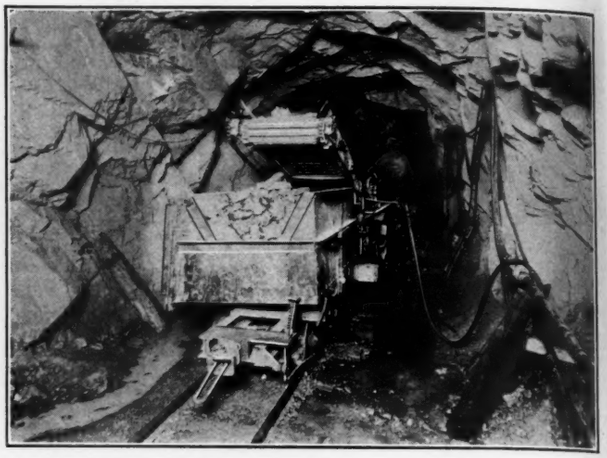


*Rock-crushing plant where rock excavated from the tunnel was crushed for use in lining tunnel.*

*Looking eastward, showing upstream side of the concrete core wall of the dam.*



*Hoar compressed air mucking machine at work in Big Creek tunnel. The machine resembles a miniature steam shovel with a telescoping dipper stick. The apparatus is small enough to be sent up and down a shaft.*



*Myers-Whaley mucking machine at work loading a car in Priest tunnel.*

machine permits inspection and repair work at the camp shops at regular intervals so that breakdowns while in service, are infrequent.

Some characteristics and performance data of the two types of mucking machines on the Hetch Hetchy job are as follows:

| | MYERS-WHALEY | HOAR |
|---|---|---|
| Smallest size drift in which machine should be used | 11 ft. x 11 ft. | 7 ft. x 7 ft. |
| Height of discharge | 7 ft. | 4½ ft. |
| Width of cut machine will make | 20 ft. | 14 ft. |
| Muck loaded per minute of loading time: | | |
| In tons | ¾ | ½ |
| In cubic feet | 16 | 10 |
| Tons loaded per hour of loading time, average, including all delays | 20 | 10 |
| Personnel of crew: | | |
| Operator | 1 | 1 |
| Muckers | 3 to 4 | 3 |
| Air pressure in pounds | | 70 to 90 |
| Air consumption per minute when operating, in cubic feet | | 300 |
| Electric motor rating | 20 H. P. | |
| Best size of car for loading with machine | 3 cu. yd. | 2 cu. yd. |

The mucking machines load into side dump-cars, of which there are about 100 of steel construction, with a load capacity of 50 to 52 cubic feet each, and about 75 of wood and steel with a load capacity of about 80 cubic feet each. The rock is taken from the faces in train loads of five to eight cars. Electric storage-battery locomotives are used for hauling the muck trains from the tunnel headings to the dump.

The storage-battery locomotive was selected in preference to the trolley type for several reasons, one of which is the elimination of the exposed trolley wire in the tunnel and the avoidance, thereby, of various hazards, such as shock, setting off powder by an arc due to accidental grounding, etc. Furthermore, the trolley involves more or less inconvenience in continually extending it as the tunnel progresses and in moving it and the tracks on the dump. The locomotives are of two sizes, four and five tons respectively: the smaller one being used in the 11-foot 3-inch tunnel section and the other in the 13-foot 4-inch section.

The shafts have three compartments: two hoisting compartments, 4½ feet square, and a manway 4x4½ feet.

Self-dumping skips, each of 32-cubic-foot capacity, are used to hoist the muck. The Big Creek shaft plant comprises the usual equipment for driving two headings as well as the necessary machinery for hoisting and pumping through the shaft. The hoist is driven by a 150-horse-power motor connected by flexible coupling and gear reduction to the clutch pinion shaft, operating double drums fitted with heavy post brakes.

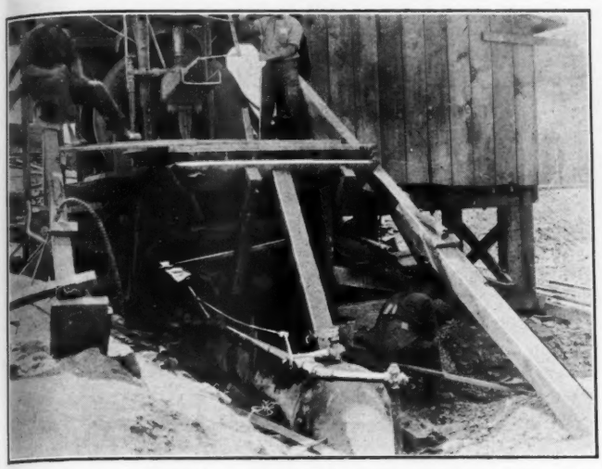
The customary head frame, with rock bin, is installed at the surface, and the shaft and the head frame are equipped with two self-dumping skips together with the needful dumping apparatus at the top and loading apparatus at the bottom of the shaft. For final disposal, the rock is loaded at the bins, through chutes controlled by pneumatically-operated gates, into Western two-yard, air dump-cars which are hauled by mules to the edge of the dump or to a rock-crushing and screening plant, which produces ballast for the Hetch Hetchy Railroad.

Below the tunnel level, which is 575 feet beneath the collar of the shaft, there is a rock pocket, with a capacity of about 3,000 cubic feet, into which the excavated material from both faces is dumped from the muck trains through a rail grizzly. At the bottom of the rock pocket, about 30 feet below the tunnel level, there are pneumatic-cylinder-operated rock-bin gates arranged to load the skips in both hoisting compartments. These gates are controlled by a skip tender in the pump station, at a level with the skip landing. The usual time required for loading a skip is fifteen seconds. From the skip landing and pumping station level the shaft extends downward 34 more feet and forms a sump—the total depth from collar of shaft to bottom of sump being 646 feet.

*Muck train, drawn by 4-ton electric storage-battery locomotive, at Priest tunnel portal.*

At the tunnel level, the tunnel excavation is enlarged, for by-pass and double tracks, to a width of about sixteen feet for a length of approximately 120 feet; and there are also two or three recesses at the side for storing and repairing electric locomotives, mucking machines, and cars.

The pumping equipment in this shaft consists of one motor-driven, centrifugal turbine pump, having a capacity of 250 gallons per minute, situated in the pump station 612 feet below the surface, taking its suction from the sump, and discharging to the surface; and of a second motor-driven, centrifugal turbine pump, of a capacity of 800 gallons per minute, now being installed in the tunnel 575 feet below the surface and about 200 feet east of the shaft, to discharge from a sump in the tunnel to the surface. The water entering the west heading is pumped from the face to the latter sump by an electrically-operated centrifugal pump. The east heading drains by gravity to the sump. The shaft is also equipped with a 350-gallon baling tank for use in an emergency. A second motor-driven pump, of 250 gallons capacity per minute, is installed in the 612-foot station to handle the water from the shaft sump to the tunnel sump, thus avoiding the necessity of operating the main pumps in this station except in case of need. No troublesome problems were encountered in sinking this shaft. The maximum sustained rate of progress was three feet per day.



*Universal concrete gun installed at Priest reservoir and used from a fixed position to place concrete tunnel lining under the impulse of compressed air.*

*Pressure grouting outfit employed in grouting rock seams in bottom of excavation for the core wall of Priest dam.*

The Second Garrotte shaft is still in course of construction, a great deal of trouble having been experienced on account of water-bearing seams. It is in diorite, crosscut by steeply inclined quartz seams. A large part of the water was cut off by grouting; but the work of grouting is slow and not uniformly successful owing to the shattered condition of the rock adjacent to some of the water-bearing seams.

Where grouting has been resorted to, the method used is as follows: pilot holes, generally two, are carried about fourteen feet in advance of the bottom. Where these indicate water, a number of holes, about three feet apart, are drilled around the walls, angling out beyond the shaft area. These are usually about eight feet in depth. Into the collars of these holes 2-inch pipes, wrapped with flannel or other similar material, are driven. Valves are fitted to the ends of the pipes. The grouting line, a 2-inch pipe from the surface, is connected to these valves by means of a high-pressure hose. The grout, generally neat cement mixed thin, is forced, by compressed air, from receiving tanks at the surface. A pressure of 100 pounds is first applied to a point of refusal and then a booster compressor is used for the work which raises the pressure to as high as 350 to 400 pounds. The operation is controlled by electric signals.

Occasionally, flows of 250 gallons of water per minute have issued from a single drill hole under a pressure of 80 or 90 pounds, and have been entirely cut off by grouting.

The head frame, dumping apparatus, rock bin, etc., at the surface are practically the same as at Big Creek; and the arrangement of the rock pocket, pump station, etc., at the bottom of Second Garrotte shaft will probably be like that at Big Creek. The maximum rate of progress for any month was 57 feet. The shaft will not be completed in time to drive a great length of tunnel westerly from it; but it is necessary, in order to maintain the schedule, to complete the tunnel east to Big Creek while lining is in progress between Second Garrotte and Priest.

The quantity of water to be handled is now 1,800 gallons per minute, but, on occasions, has been as much as 2,000 gallons. This necessitates a heavy investment in pumping equipment; and the outfit is as follows:

Pump station at 250-foot level:

1 Gould triplex plunger pump, 7x10 inches, 250 gallons per minute, pumps from sump into pipe line which runs to Groveland to supply water to the town.

1 Allis-Chalmers 4-inch, 2-stage turbine pump, 600 gallons per minute, pumps to surface.

1 Air lift, 7-inch, double-leg, 500 gallons per minute, using 1,000 cubic feet of free air per minute. This is an emergency installation in case of failure of electric power.

Pump station at 465-foot level:

3 Cameron 5-inch, 3-stage turbine pumps, 750 gallons per minute each, pumping to surface through 10-inch pipe.

1 Jeansville 5-inch, 2-stage turbine pump, 500 gallons per minute, pumps to station at 250-foot level.

Sump at 495-foot level:

1 No. 7 Cameron air sinker, 100 gallons per minute, pumps to 465-foot station.

Sump at 530-foot level:

1 Blake-Knowles Texas slush pump, air operated, 300 gallons per minute, pumps to 465-foot station.

Ring at 568-foot level:

1 Krogh centrifugal sinker, 4-inch, 3-stage, 400 gallons per minute, pumps to 465-foot station.

*Timbered section of aqueduct tunnel near Big Creek shaft.*

Bottom of shaft (623 feet down on April 30, 1922):

2 Krogh centrifugal sinkers, 5-inch, 2-stage, each of 650 gallons per minute.

Spare sinking pumps include one No. 7 and two No. 9 B. Cameron air-operated pumps, and two 400-gallon Krogh centrifugals. All the pumps are operated by electric motors except as otherwise noted.

A sub-contract has been let to the Universal Concrete Gun Company for lining tunnels having a cross-section as shown in Fig. 2. Most of the concrete is to be placed by means of a pneumatic system which has been successfully used in California in tunnels recently driven in connection with some hydro-electric power plants. The pneumatic method is preferred to hand placing in the side and arch lining, as previous experience in other projects has shown that a denser concrete is obtained, and that the arch is more completely filled and packed when the concrete is shot forcibly into place by compressed air.

The Universal concrete gun was developed by W. F. Webb and A. P. Cox and is designed to be loaded directly from cars standing on the tunnel track. This can not be conveniently done with any previous type of concrete gun. Its construction is shown in Fig. 4.

With the concrete gun located four miles from the source of materials the problem of transportation of concrete to the gun becomes serious. Concrete mixed at the tunnel portal and hauled such a distance would be subject to partial segregation and, possibly, to initial setting of the cement.

To obviate these conditions, a portable conveyer and mixer plant has been designed for use in the tunnel, and will be employed in the Priest heading, where lining will begin.

The forms for the lining of the sides and arch are made of structural steel frame with wooden surfaces, furnished by the Blaw-Knox Manufacturing Company. Each unit is 40 feet long. The placing of the floor or invert lining will be the last step in the lining of the tunnels. The concrete gun will not be used for this work.

The concrete will simply be spread and screeded to the proper profile.

The hydraulic fill is of material taken from the hillside adjacent to the upstream part of the dam. The formation is of shattered and partly decomposed rock containing considerable fine material and a fair percentage of clay—probably from 10 to 15 per cent. It is loosened by blasting, and then is washed down by the jet from a hydraulic giant. So far only one giant has been employed, but a second is to be installed so that while one giant is in service preparations for blasting may go on at the other pit. Water is supplied the giant by a Byron-Jackson single-runner, high-speed centrifugal pump, of 4,000 gallons per minute capacity, under a pressure of 165 pounds per square inch. The pipe from the pump to the giant is fourteen inches in diameter. Both wood-stave and steel pipe are utilized. Generally a 3-inch nozzle is used on the giant, and then the discharge is about 3,700 gallons per minute.

The mixture of water and solid material is caught in a wooden flume; led to the dam; carried out over the dam in a steel flume of U-shaped section supported by trestle bents on a 6 per cent. grade; and distributed thence through short, steep side flumes also of steel. The steel flume is twenty inches wide and twelve inches deep, of No. 14 gage material. A sheet of No. 10 gage, hard, red iron, eighteen inches wide, is riveted in the bottom of the flume section. This sheet, which takes the wear due to the material passing through the flume, can be renewed when necessary. The flume is made up of 29-foot lengths. At the lower end of each length is a gate three feet long, which is hinged at the upper end and provided with a handle at the lower end so that it can be conveniently swung up out of the line of the flume—thus permitting the sluiced material to drop into the upper end of one of the side flumes. The arrangement and details of the flume system are shown in some of the photographs.

The trestle bents will gradually become embedded in the fill; and, later, the flume system will be reconstructed at a higher level. The water supply for the work is obtained from the Priest Tunnel heading. It amounts to about 100 gallons per minute, and is used repeatedly through the giant.

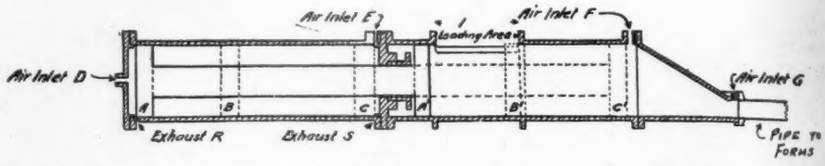



*Fig. 4. General arrangement of the Webb Universal concrete gun. The horizontal cylinder, 24 inches in diameter, is divided into two compartments: one houses an air-operated piston and the other carries a plunger which expels the charge of ten cubic feet of concrete. These pistons are tied together by a single piston rod. A and A¹, B and B¹, and C and C¹, indicate, repectively, the loading, the intermediate, and the discharge positions of the pistons. When the pistons are at C and C¹, compressed air is admitted at F and G to blow the concrete from the gun and to agitate the mass as it passes out and onward to the forms.*

The downstream embankment, now under construction, is an earth-and-rock fill, excavated from the adjacent hillside by steam shovel and dumped into the embankment from trains of side-dump cars hauled by steam locomotives. The lower part of the upstream embankment has also been built in this manner. The upstream face is being paved with riprap, as a precaution against damage due to wave wash.

The concrete core wall is of unusual design. It is six feet thick at the base and tapers to two feet at the top. It is not intended to resist lateral pressure, but has horizontal and vertical joints dividing it into sections 50 feet long and sixteen feet high. Flexible waterstops of sheet copper seal the joints. These joints are keyed in a manner which will allow considerable deflection. Thus when, in the course of time, unequal settlement of the two halves of the dam causes unbalanced pressure to act against a part of the wall, that part will yield until equilibrium is reëstablished—the joints permitting such movement without impairing the watertightness of the wall by cracking.

A contract was let for the building of what is to be known as Pulgas tunnel, about 8,500 feet long, between Redwood City and Crystal Springs reservoir. This is the initial construction unit of the aqueduct, which, as previously mentioned, is to be used first to carry the Calaveras water of the Spring Valley system. This tunnel, lined with concrete, will have the same cross-section as the Sierra Nevada tunnels, that is, ten feet three inches high and wide inside of lining. The contract price is $62 per foot, with an additional charge of $18 per foot where permanent, systematic timbering is used. Grant Smith & Company is the contractor.

At the lower end of the Mountain Division Tunnel is the site of Priest Reservoir, the forebay of the Moccasin Creek power plant. The reservoir is to have a capacity of 2,500 acre-feet, and is to be formed by Priest Dam, now under construction. This dam will be an earth-and-rock fill of 800,000 cubic yards, with a concrete core wall.

The greater portion of the rock removed from the Priest tunnel heading is being dumped to form the downstream toe of the dam. The major part of the upstream half of the dam is to be placed by hydraulic sluicing, which, in itself, should make an impervious embankment. The concrete wall or diaphragm will, however, assure absolute tightness. In the downstream half, imperviousness is not necessary, nor is it particularly desired. This section of the embankment is to be built of any convenient material by dumping it from a trestle and washing it down into place by means of jets.

The construction of the Hetch Hetchy water supply system is being carried out under the direction of M. M. O'Shaughnessy, city engineer of San Francisco. Nelson A. Eckart is chief assistant engineer, in charge of design and construction. The other principal members of the engineering staff are:

Headquarters office: Leslie W. Stocker, assistant engineer; Raymond P. McIntosh, hydraulic engineer; Edwards P. Jones, mechanical engineer; Paul J. Ost, electrical engineer; C. L. Cook, engineering chemist.

Construction engineers: C. R. Rankin, in charge of the Hetch Hetchy dam construction; L. T. McAfee, in charge of aqueduct tunnel construction, and also superintendent of Hetch Hetchy Railroad.

Among the eminent consultants, who have at various times been engaged, are John R. Freeman, Charles D. Marx, and Desmond Fitzgerald, all of whom are past presidents of the American Society of Civil Engineers; John D. Galloway, civil engineer; Frank G. Baum, electrical engineer; Dr. William F. Durand, mechanical engineer; and Dr. James C. Branner, geologist.

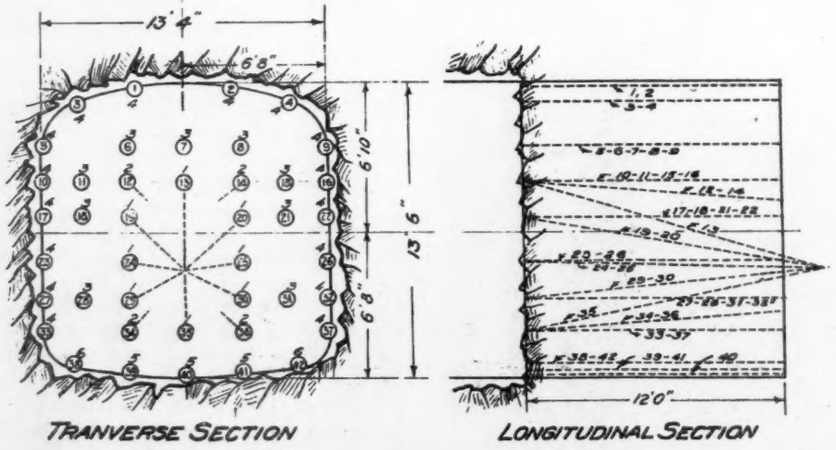



*Fig. 3. Drilling diagram of South Fork headings.*

Over 17,000 miles of cloth are needed every year to make new cement sacks. To turn out a 30-inch strip of cotton fabric of this length calls for the working up of 15,000,000 pounds of cotton—a job of sufficient magnitude to keep 1,600 looms busy every day of an entire twelve-month.

The Esthonian Government is erecting at Kochtel a mill for the extraction of oil from oil shale. The plant will be able to handle 200 tons of shale every 24 hours.

## SMALL VERTICAL BELT-DRIVEN AIR COMPRESSORS

THE INGERSOLL-RAND COMPANY, 11 Broadway, New York, announces a new line of small, vertical, belt-driven air compressors, known as Type Fifteen. In addition to the plain belt drive design, each size is built to be a self-contained electric motor outfit, driven either by pinion and internal gears, as shown in the accompanying illustration, or by the short belt arrangement. The compressing end and the electric motor of both the gear and the short belt-drive units are furnished mounted on a common sub-base, so that they are in no way dependent upon the foundation for correct alignment.

Several noteworthy features of construction have been incorporated, of which the "Constant-Level" lubrication system is the most important. Others include the constant-speed unloader for plain belt-drive machines; the centrifugal unloader for start and stop control machines; and the increased size of the water reservoir cooling pot.

The lubrication of small vertical compressors, employing the enclosed crank case and splash system, has often been a source of concern wherever oil in the air is a serious menace. The tendency of the old system has been to feed too much, resulting in discharged air containing excess oil, or too little, causing scored cylinders, excess loads, and burned out bearings. The "Constant-Level" system used in Type Fifteen compressors automatically maintains a constant-level of oil, which insures the right amount being distributed to all parts.

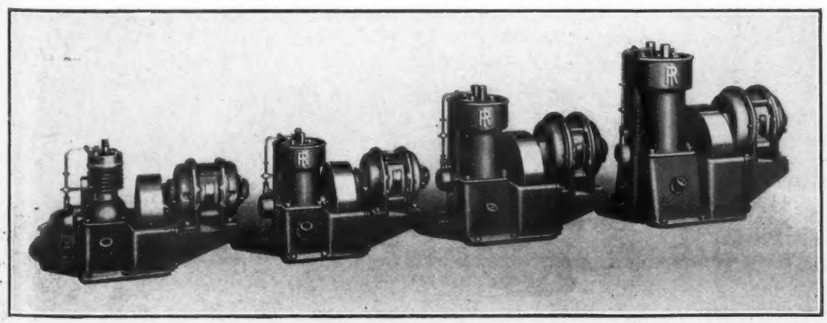
As with the ordinary splash system, the base of the compressor forms an oil reservoir for the "Constant-Level" system. However, with this system, pet-cocks determine the maximum and the minimum amounts of oil in the reservoir. Above this reservoir, and directly underneath the connecting rod is a constant-level pan. Oil is pumped from the reservoir into this constant-level pan through a unique oil pump. Regardless of the amount of oil in the reservoir, so long as it is somewhere between the high and the low level pet-cocks, this system will function perfectly, insuring a constant level of oil in the pan. A projecting stem on the connecting-rod dips into this pan and distributes just a sufficient quantity of oil for proper lubrication.

The constant speed unloader controls the unloading of the compressor by automatically opening the inlet valve when the receiver pressure rises above that at which the unloader is set to operate. When the receiver pressure has fallen a predetermined amount, the unloader automatically releases the inlet valve and allows the compressor to return to work and thus to build up the receiver pressure again.

The centrifugal unloader allows the compressor to start under "no load," such as is essential when automatic start and stop control is used, and permits the electric driving motor to come up to full speed before the load is thrown on automatically. This unloader accomplishes its purpose by holding the inlet valve open until the motor has reached full speed.

The smallest size is built with either a ribbed cylinder for air cooling, where the service is intermittent, or a water-jacketed cylinder of the reservoir type for constant service. All other sizes are provided with only the water-jacket of the reservoir type. The capacity of these reservoir pots is very generous, and one filling will be found ample for long periods of operation.

A bulletin has been issued on these compressors which describes in detail all of their features including some not herein mentioned. A copy can be secured by writing to the company referred to.



*The family of Type Fifteen vertical electrically-gear-driven air compressors showing the 3-inch air cooled, the 3-inch, 4-inch, and 5-inch water-reservoir-cooled machines.*

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## A DISTINGUISHED ITALIAN ENGINEER HONORED

THROUGH the able direction of Mr. Charles F. Rand, president of Engineering Foundation, a luncheon was given at the Bankers' Club, New York, on September 26, to Dr. Federico Giolitti, a distinguished Italian iron and steel metallurgist, who was managing director during the war of the great Ansaldo Works at Genoa. Dr. Giolitti's father is Prime Minister of Italy.

The following were present:

Dr. Federico Giolitti, guest of honor.

M. Gaston Liebert, Consul General of France.

Comm. Franceso Quattrone, consulting engineer.

Col. Percy E. Barbour, asst. sec'y, Am. Inst. of Min. & Met. Engrs.

Edward D. Adams, vice-chairman, Engineering Foundation.

Wm. Campbell, professor of metallurgy, Columbia University.

Frank D. Carney, consulting metallurgist.

Alfred D. Flinn, director, Engineering Foundation.

James T. Grady, Dept. of Public Information, Columbia University.

John H. Hall, secretary, Iron & Steel Committee, A. I. M. E.

Henry D. Hibbard, consulting metallurgist.

W. R. Ingalls, consulting engineer.

A. H. Jameson, vice-pres., Bayonne Steel Casting Co.

Wilber Judson, Texas Gulf Sulphur Co.

A. R. Ledoux, past pres., Am. Inst. Min. & Met. Engrs.

Edwin Ludlow, past president, Am. Inst. Min. & Met. Engrs.

John W. Lieb, past pres., Am. Soc. Mechanical Engrs.

D. A. Lyon, chief metallurgist, Bureau of Mines, Washington, D. C.

John A. Mathews, president, Crucible Steel Co. of America.

J. V. W. Reynders, consulting engr., vice-pres., A. I. M. E.

Charles F. Rand, chairman, Engineering Foundation.

Bradley Stoughton, chairman, Iron & Steel Committee, A. I. M. E.

W. R. Shimer, metallurgist, Bethlehem Steel Co.

W. L. Saunders, past president, Am. Inst. Min. & Met. Engrs.

Leonard Waldo, consulting metallurgist.

Edward D. Adams, vice-chairman, Engineering Foundation.

Brief addresses were made by Mr. Lieb, Mr. Stoughton, Dr. Ledoux, Mr. Adams, Mr. Saunders, and the Consul General of France. Attention was called to the fact that during the World War the Ansaldo Works, under the able direction of Dr. Giolitti, provided munitions for the Italian armies that were unprecedented in volume and in quality. It was pointed out that many years ago, when the Ansaldo family controlled the plant, Germany endeavored to purchase stock in the enterprise because of its location at Genoa, an important shipping point; and that at the funeral of the senior member of the family, the surviving Ansaldo brothers shook hands across the coffin and swore that they would never permit Germany to own one dollar's worth of stock in the works. This vow, which, at the time, may have been inspired purely by sentiment, was of very practical value in that these works saved Italy at a critical period when it was practically impossible for the Allies to supply her armies with the guns needed. Dr. Giolitti is regarded as one of the foremost steel metallurgists of the world. He is, furthermore, prominent in research and an executive of rare ability. A sympathetic note was touched upon by the Consul General of France when he spoke of the great influence upon the world of the getting together of organizations of intelligent people, such as engineers, for the purpose of honoring a man like Dr. Giolitti—a descendant of Greco-Roman civilization of which all of us, the Anglo-Saxons included, are a part. He expressed the hope that there would grow in the future more of an international comity among all the races and less of national feeling in so far as nationality conflicted with the interests of the whole human race.

The luncheon was given by the Iron and Steel Committee of the American Institute of Mining and Metallurgical Enginers.

## CONTROLLING PRODUCTION BY COMPRESSED AIR

*By JOSEPH SALATHIEL*

ONE OF THE BIG problems connected with the administration of any large plant engaged in the manufacture of a more or less complex product is to regulate the work of contributive departments so that the flow of associate features will be in reasonably close accord with the scheduled output of the complete commodity.

All too often the various subdivisions of such a factory operate with only incidental regard to the requirements of the other allied sections of the establishment; and the result is so unbalanced that not infrequently a casual taking of stock reveals overproduction of some parts and a corresponding shortage of others. In brief, there is a lack of coördination that is apt to invite inconvenient and possibly costly conditions.

To obviate such a state, the H. H. Franklin Manufacturing Company of Syracuse, N. Y., in 1915, instituted a novel system of centralized control, and, after a careful study of the needs of each department, created facilities by which every section of the works could be kept appropriately engaged in meeting the demand for Franklin cars. The basis of the system is a thorough knowledge of the maximum capacity of every machine tool in the plant; and the function of the Control Department is to send out, at suitable intervals, orders for the making of a definite number of essential features. Let us explain how this is achieved.

In the Control Department there are a series of control boards on which are mounted for graphic display numerous little blocks which indicate the several steps or operations by which a particular part is developed from the raw material to its finished form. At the lower edge of each of these lattice-like charts which, after the fashion of a Venetian blind, can be shifted vertically, there is a scale which enables the operator to determine when a job should be started and just how long it should take to complete it. Job cards are dispatched to the different production departments, and each workman, as he finishes his task, sends the card allotted to him back to the control central. In this way, it is quite practicable to have a comprehensive grasp of the multiple activities of the factory, and to regulate output. Compressed air performs a very useful service in effecting the distribution and the return of the job cards.

Courtesy, H. H. Franklin Manufacturing Co.

*A clerk in the "cage" dispatching a job card to an operative waiting at the other end of the pneumatic line.*

Courtesy, H. H. Franklin Manufacturing Co.

*A workman returning a job card to the Control Department upon the completion of the task assigned him. A few seconds later he receives by the same medium an order card for his next job.*

The pneumatic tube system required for this service was installed seven years ago, and since then it has been used continuously and to the satisfaction of all concerned. A tube system was adopted so as to permit the organizing of a central dispatch-room; and all dispatch clerks are located in this room or "cage." When a worker reports by card, by the proper pneumatic artery, that his job is done a new order is immediately sent to him by the same route. This procedure has made it possible for the company to eliminate personal contact between clerk and worker; to avert all unnecessary communication; and jobs are assigned according to date without regard to the individuality of the operative so long as he is capable of executing it. According to one of the officials: "Our present equipment has enabled us to meet all of the demands placed upon the plant, and has helped to create harmony between the worker and the management."

The installation comprises 6,000 feet of tubing, composing 24 lines of communication—two of them three and one-half inches and the remainder two and one-half inches in diameter. The carriers are of leather, slightly less in diameter than the tubes, and each is provided with a felt washer at the bottom in order to make it fit the tube snugly. The washers act as gaskets or pistons against which the air pressure works. A carrier, when inserted in a tube, travels at the rate of 125 feet per second under a constant impulse of a 5-pound pressure; and the average time required to send a carrier to its destination is twenty seconds. The compressed air is furnished by an electrically driven compressor equipped with a 35-horse-power motor. Part of the outfit consists of a reserve tank which is kept continually charged at a pressure of 25 pounds; and, by the interposition of a reducing valve, a uniform pressure of five pounds is maintained in the carrier tubes.

At each terminal, there is a box, and at the base of the latter is placed a sand-bag. The sand-bag absorbs the impact and the box prevents the arriving carrier from bounding out. As soon as a carrier drops into the receiver, the seal at the opposite end of the line is released and the tube is again free to handle another message. Each line is timed separately, depending on the distance it covers, so that there will be no premature opening of a tube before a carrier has reached its destination.

It should be self-evident that the whole system cuts out lost motion, insures well-balanced production agreeably to the needs of each season of the year, and is the means of saving much valuable time—in other terms, money.

## PULVERIZED FUEL HANDLED BY COMPRESSED AIR

SOME FURTHER details regarding the equipment to be used in handling the pulverized coal at the New Cahokia Station of the Union Electric Light & Power Company, St. Louis, Mo., have been announced.

Among these, the method of weighing the fuel and conveying it from the pulverizers to the boilers is of unusual interest. Below the floor level of the pulverizing room will be placed a series of five blowing tanks, which serve an equal number of twin pulverizing units. These blowing tanks will rest on platform scales, the dial of which will indicate to the operator in the pulverizing room the amount of fuel in the tank.

The fuel will feed into these tanks by gravity, as desired, from the pulverized fuel bins in the pulverizing room. Each charge will be automatically weighed, and then elevated about 75 feet, by compressed air, through 4-inch pipes. A simple system of switching valves and parallel distributing mains, cross connected, enables any blowing unit to be discharged into any of the eight enclosed storage hoppers in the boiler house. These hoppers serve the four pairs of boilers, each of 1,780 H. P., comprising the first group of boiler units to be installed.

The fuel requirements for the first group of units are estimated at 1,000 tons in sixteen hours. This equipment was selected on account of its cleanliness and freedom from mechanical complications which would be liable to interrupt service. The contract has been awarded to Quigley Fuel Systems, Inc., of New York.

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On the 31st of August of the current year, Gothenburg, Sweden, formally opened its freeport. Gothenburg, founded three centuries ago, is the second largest of the Swedish cities and the most prominent of that country's ports. The freeport idea has taken a firm hold upon the imagination of European men of commerce.

# Mining Sodium Nitrate In Chile

## It Is From These Beds That the World Gets Most of Its Indispensable Saltpeter

By PETER A. RAYMOND*

THE FERTILITY of the farmer's fields; the powerful propellants for national defense; and the preparation of dyes and many pharmaceutical commodities depend in varying degrees upon the chemical properties or the reactions induced by nitric acid. Without this corrosive substance at his command man would be hard put to it to do a wide range of things needful to his well-being, comfort, and protection.

Fixed nitrogen is obtained from divers sources, and all of this material, in whatever form, has practical uses; but, generally speaking, the supplies are comparatively limited because of their scattered and diversified origin. There is one outstanding exception, and that is the nitrate beds of Chile, which have been worked for decades and have furnished the industrial world with a vast tonnage of wonder-working saltpeter.

Paradoxically, these deposits of sodium nitrate are situated in a singularly barren region, and yet this salt is able to revitalize a depleted soil and to make it capable of yielding crops of great abundance. The manner in which these beds were formed is another evidence of how Nature seems to have foreseen man's potential wants and to have provided for them in her own peculiar way. The story is another leaf from the history of the geological evolution of this globe of ours.

There is an arid stretch in Chile, lying between the Pacific coast and the foothills of the Andes, which is to-day our main reliance for sodium nitrate in commercial quantities. This section of Chile covers a distance north and south of about 430 miles, and is situated between latitude 19 degrees and 25 degrees South. Throughout this region there is no vegetation, nor is there any rainfall. The probable and the generally accepted theory of the genesis of these deposits is that advanced by Nöllner, who assumed that the present plateaus of Atacama and Tarapaca were originally below sea level. Gradually, during the upbuilding of the Andes, the sea bottom was pushed above the ocean carrying with it enormous amounts of seaweed or wrack; and in the course of time this marine matter was concentrated within a restricted area which ultimately reached an altitude varying from 1,500 to 1,800 feet. As this inland sea was slowly forming, additional quantities of seaweed were swept into it over the low coastal barrier during seasons of stormy weather. In the interval of this terrestrial transformation, the impounded mass of aquatic vegetation decayed under conditions of temperature especially favorable to the action of nitrifying bacteria; and as rain was well-nigh unknown, and there was no drainage, the residual product remained intact. Later on, sand and dirt, blown by the winds, formed a blanket over the dried out erstwhile sea-bed, and thus buried the saltpeter.

**THE merits of Chilean nitrate as a fertilizer are fully recognized and acknowledged despite the encroachments of competing products. The trade outlook for this source of substantial revenue to Chile is far more favorable now than it has been during the past two years.**

**Stocks of this salt in Europe and in the United States have diminished to a point where they are considerably lower than those normally carried, and it is therefore reasonable to forecast a growing demand for the commodity and to predict a new era in the business.**

**It should be of interest to the world at large to know more about the Chilean deposits of saltpeter and to understand how the adoption of power-driven tools may go a long way toward improving the economic aspects of this vitally important industry. The use of pneumatic drills and of compressed air have blazed the path to a potential revolution in this field of mining activity.**

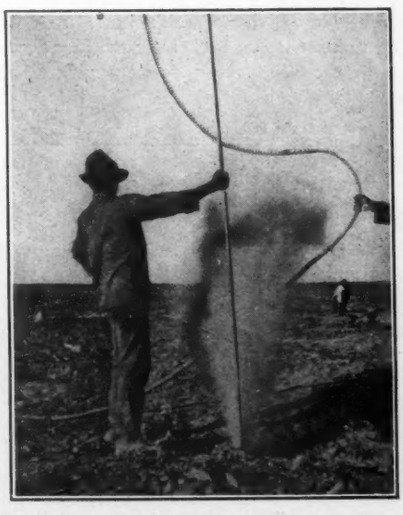
Nitrate has been mined in what is now known as the northern part of Chile for the past 63 years—in fact, operations were begun two decades before the War of 1879 between Chile and Peru, and it was the enormous wealth of these nitrate *pampas* that was indirectly the cause of that conflict. Chile's acquisition of the territory has proved more or less of a thorn in Peru's side ever since. The following account of nitrate mining in Chile has been inspired by a desire to show how modern methods and the employment of pneumatic tools have speeded up production in a way to meet more economically the ever-growing demand for this mineral.

The normal, annual production of Chilean saltpeter before the World War was approximately 50,000,000 quintals, each of 100 pounds, or 2,500,000 tons. Taking into consideration the percentage of nitrate in the rock and the loss in handling and elaboration, this represents 15,000,000 tons of nitrate-bearing rock extracted; that is to say, for each ton of pay material one ton of waste must be moved and handled, which gives us a total of 30,000,000 tons of material moved every twelve months. The

*Mr. Raymond is the technical superintendent of the Extraction Department of the Cia de Salitres de Antofagasta.

*Drilling a 14-inch hole on the rajo Prudencia with the "Jackhamer."*

*The "Jackhamer" replacing hand work in drilling vertical holes.*



*Blowing out a hole with compressed air after springing.*

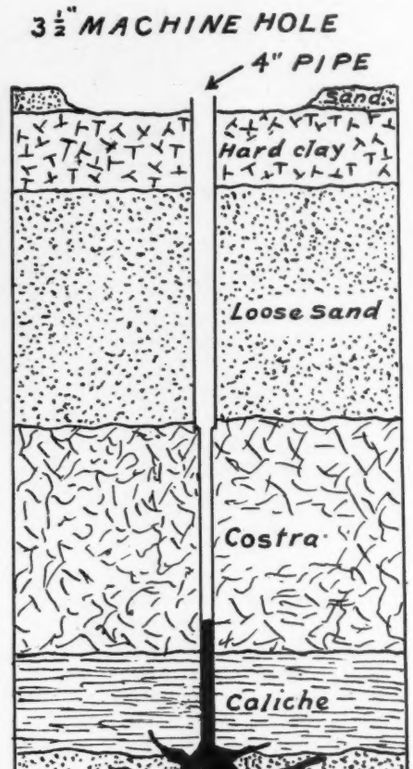
common practice has been to drill, to sort, to manipulate, and to load the stuff entirely by hand.

The formation is sedimentary and the nitrate-bearing material, locally known as *caliche,* is encountered under many different conditions from clean salts, in a horizontal strata running up to 70 per cent. nitrate, to an impregnated mass of low grade, uncommercial material. It is found from the surface down to a depth of 30 feet. In many cases it is in the form of a bed of conglomerate water-worn pebbles and boulders in which the cementing material contains the values. The boulders and pebbles are igneous and porphyritic rocks, while the cementing material is of the hardness of hard salt. When one considers that this material contains crevices and vug holes with loose pebbles one can appreciate the difficult drilling conditions.

The accompanying sketches show two typical conditions. The *Prudencia* trench, locally called *rajo,* shows a conglomerate *caliche* of 16 per cent. nitrate, and the *rajo Peniete* shows a *caliche* strata of 40 per cent. nitrate, with a heavy overburden. There is another formation, called a *salar,* which is a nitrate-bearing rock containing a high percentage of salts. This stratum lies on the surface, and is from one to five feet thick. Beneath the *caliche* is the *coba,* which is a soft, sandy material; and there is also a *banco,* a fairly soft, salty soil containing small pebbles. Both of these lend themselves to springing.

The question of mechanically drilling the different *pampas* has been studied during the last ten years by nearly all of the large manufacturers of rock drills in the United States and in Europe, but, until latterly, none of the nitrate producers, with the exception of the Cia de Salitres de Antofagasta, has adopted these modern facilities. Several reasons have influenced this course: a very variable and difficult formation to drill; old-fashioned ideas entertained by the nitrate producers which the manufacturers of rock drills found difficult to change; and lack of patience in experimental work on the part of the nitrate producers and the manufacturers. The nitrate producers were, and are, a decidedly skeptical class.

The method of mining is in the form of trenches or *rajos,* vertical holes being drilled four to sixteen feet back from the face according to the depth. An accompanying sketch shows the form of the hole. The hole is dug




*The geological formation of the rajo Peniete.*

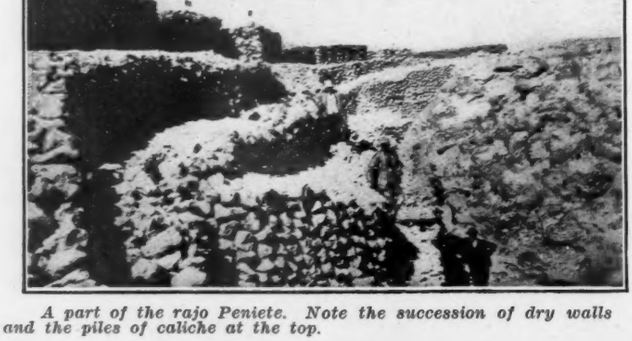
instead of drilled in the following manner: The driller first makes what is called a *discostra,* that is a hole three to four feet in diameter and from three to seven feet deep, depending on the total depth. The object of this *discostra* is to enable him to get down a way, because the longer the small part of the hole the more difficult it is for the driller to handle his bars and spoon. The material is loosened with a punch bar and extracted with a spoon bound by rawhide to a stick. In hard material pop holes are drilled, and small particles are fished out with the spoon. The tools used are an assortment of punch bars with points at different angles, an 8-pound hammer, hand steels, and the spoon mentioned. On reaching the *coba,* the hole is widened out, forming a *tasa* to receive the charge of black powder, which is made on the property. This explosive is of a very inferior grade compared with black powder as we know it in the quarries of the United States. (A workman here tamps powder in a block hole with an iron bar and an 8-pound hammer). These holes are from six to sixteen inches in diameter. In the old days so it is said, they used to be made even larger and the practice was to lower a small boy head first into the hole. With a short steel tool sharpened at both ends, called a *yancana,* he loosened the material at the bottom. The charge of black powder is from 50 to 500 pounds, according to the depth and the load on the hole.

As compared with the performances of high-priced dynamite, electric detonators, etc., in Chile they have been able, with cheap labor and the use of cheap powder (about one cent a pound), to drill a large hole in *salars* in half a day, while it required ten days to do this work in deep ground. These results make it clear that the study of the proper distribution of explosives in connection with the employment of rock drills is a matter of great importance.

After shooting this large hole, the boulders were block holed by hand, using ⅝-inch steel with a chisel bit of just sufficient size to drill a hole that would admit cartridges, ¾ x 3-inch of 62 per cent. gelignite, with a No. 6 cap. The material was then sorted by hand, the *caliche* being built up in square or oblong piles from four to six feet high. The waste material was thrown or shoveled back. In deep work, dry walls must be built in as many as four or five stages in order to keep the waste material from caving into the trench.

About three years ago the Cia de Salitres de Antofagasta, seeing the hand writing on the wall with reference to shortage of labor and the need of cheaper production, purchased two Ingersoll-Rand portable, gasoline-driven compressors, one heavy sinker, and six "Jackhammers," and proceeded to do some experimental work on the Condel property. This work was not very successful, as the personnel had no previous experience of any kind with machine drills, and operations were brought to a halt owing to industrial conditions.

In July of last year it was decided to again tackle the problem in the *rajo Prudencia,* in the *Oficina Ossa,* which was considered the most difficult on account of its formation. A heavy tripod machine of the hammer type was purchased, and changed from wet to dry owing



*A part of the rajo Peniete. Note the succession of dry walls and the piles of caliche at the top.*

*Loading cars by hand with the nitrate-bearing rock.*

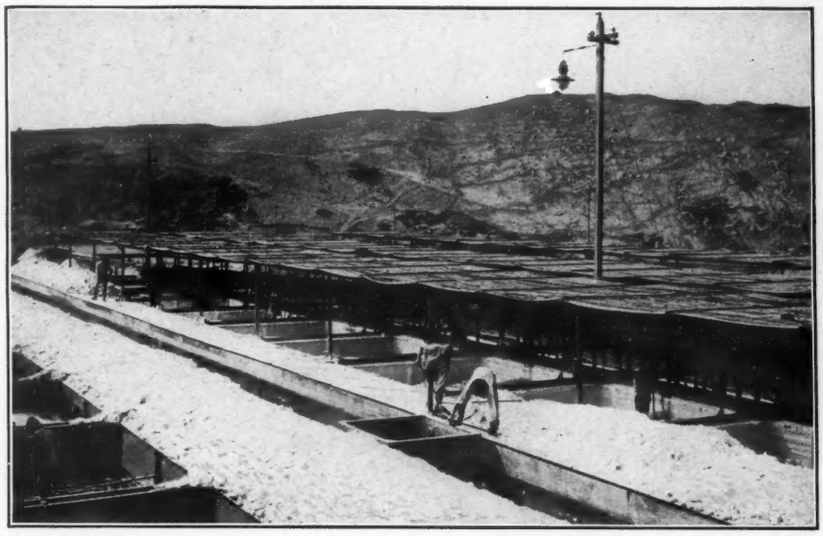
to the formation, which is more or less soluble, and to the high cost of water which make a wet drill prohibitive. Holes six inches in diameter were attempted, using a 10-point detachable bit. It was found that with a bit of such a large diameter the cutting speed was slow, especially when going through hard boulders, and that it was still necessary, even with that size of bit, to spring the hole. Moreover, the larger the bit the greater the chance of caving in when striking the loose conglomerate; and with the larger diameters it was needful to use a blow pipe to clean the hole.

The bits employed were detachable, and were of 10, 6, and 4 points, having a diameter of 6, 4, 3½ and 2 inches, respectively, adjusted to 1¼-inch round steel by a taper fit loosened by driving a long taper key through a ⅝-inch round hole very much like driving a twist drill out of the spindle of a drill press. The advantages of this construction are that the steels remain unchanged, in other words that the hole is started and finished with the same bit; and there is not the inconvenience of carting lengths of steel to the blacksmith shop which, in some cases, is as much as a mile away. The diameter of the bits was gradually reduced until now all of the deep work is done with the heavy sinker, "DDR" No. 13, using 1-inch hexagon steels, and finished with a 1¾-inch, 6-point bit.

Experiments were made in springing, and a detailed record was kept of the explosives used in each hole both for springing and for shooting. This data was put into tabulated form and was accompanied by a plan showing the location of each hole. Then blue-prints were given to the foreman and to the man in charge of the explosives. After a shot was fired, from fifteen to 30 holes, the ground broken was carefully looked over and any information worth while was recorded. In this way it was not only possible to determine the exact cost of each hole and the cubic meters of material moved, but it was also feasible to trace the reason for poor results.

Attempts were first made to spring with very light tamping; but this was not successful inasmuch as it required several springings to secure sufficient room for the amount of powder necessary. It was found that with heavier tamping the bottom of the hole was shattered more effectually. The hole was afterwards cleaned with a blow pipe. The first charge for springing is made up of from five to fifteen sticks of ¾ x 3-inch, 62 per cent. gelignite, with No. 6 cap, and plain hemp fuse. In the second charge the amount of dynamite is decreased, and native powder is used. The load per hole averages about 100 pounds of powder, one stick of dynamite, and a No. 6 electric detonator.

After springing a hole, one has a mental picture of a nice pear-shaped cavity awaiting the powder. Such is not the case. It was discovered that crevices were formed, in springing in the material to be dealt with, which ran in all directions, and that it was, therefore, impossible to fill these fissures with a tamping stick, which could not pack the powder in laterally. Experiments were made towards blowing the powder into the crevices with compressed air, and these proved very successful. In this way it is now practicable to load a given amount of powder into a hole with one-half the springing originally necessary. The procedure adopted is as follows.

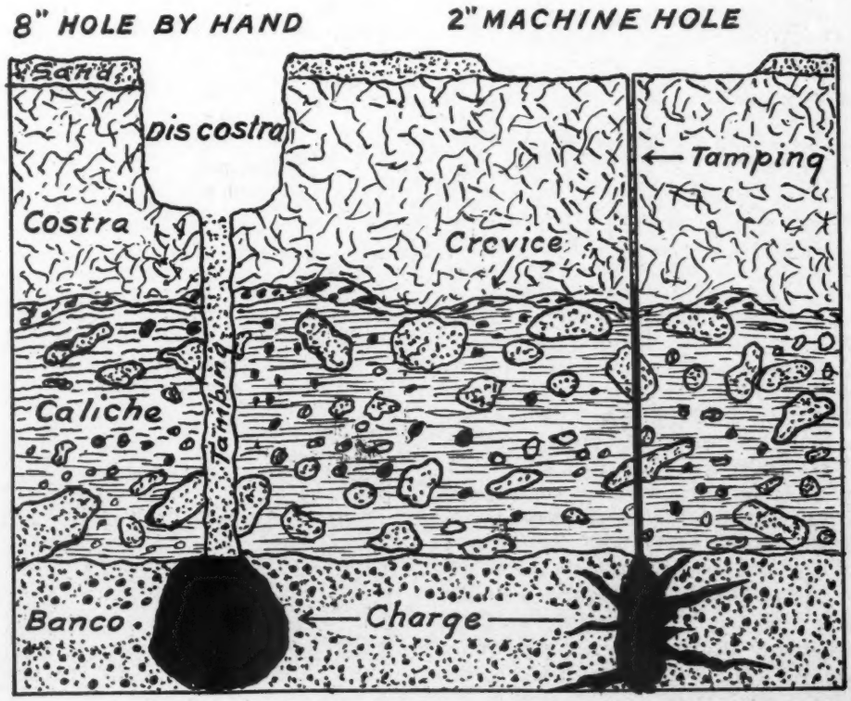


*Crystallizing tanks. The finished product is piled above the tanks and is moved thence by little tram cars to storage.*

A ⅜-inch blow pipe is lowered in the hole and into this pipe the powder is poured. Then a piece of cloth is wound around the pipe at the collar of the hole. With this done, the air valve is slightly opened and the blow pipe is worked up and down slowly, thus blowing the powder into the crevices. Holes loaded in this way assure a better lifting action under the entire mass, and do not blow out as so often happens with hand-drilled holes. In the case of the latter, it is difficult to tamp successfully owing to the large size and the irregular walls of the holes.

After shooting the nitrate-bearing material, in place, the boulders are block holed, at the expense of the company, with "Jackhamers," thereby delivering the product to the sorter in a condition which enables him to produce more *caliche* per day. The block holes run from one to five feet deep, and are drilled by a 6-point, 1½-inch diameter bit. This makes it feasible to shoot the holes with Chilean powder, eliminating the dynamite and the cap which were originally sold to the men at a loss to the company. This means a saving both to the employer and to the employee.

The figures given in the table which follows, cover averages of the last five months of 1921, and give a good account of comparative results. The unit of measurement on the *pampas* is either per cart load, equalling 2½ cubic meters, or per cubic meter. The average depth of the holes is eleven feet.




*A cross-section showing the conditions prevailing at rajo Prudencia.*

*A general view of a plant where the caliche is subjected to the extraction and purification process.*

In the *rajo Peniete* conditions are entirely different from the *Prudencia,* as can be seen by comparing the accompanying sketches. Nearly 100 holes were drilled and shot there successfully. The large tripod drill was used with a 4-inch, 6-point bit attached to a 1¼-inch round steel. On going through the hard clay capping it was found that the hole caved as fast as it was drilled. It was therefore necessary to assist the drill in the extraction of the bit by putting a blow pipe down alongside the steel. An attempt was made to dig to the *costra* by hand but that was too expensive and added to the cost of the hole. A 6-inch bit was then used to drill through the material and a few inches into the *costra.* An old piece of 4-inch pipe, of the proper length, was then inserted into the hole to below the clay, and into this, in turn, was placed a blow pipe. The air served to agitate the caved material. The pipe was worked downward with chain tongs and a double-hand hammer; and when the end of it reached the *costra* a blank bit was put into the chuck and the drill then drove the pipe securely into position. A 3½-inch bit was next utilized, and the drilling operation continued in the regular way to a depth of sixteen feet. The total drilling time in this material was on an average of one hour per hole; and the springing and the blasting were similar to that in *rajo Prudencia.* The total cost per hole was the same as that for hand drilling. In connection with this matter of drilling a representative of a large steam shovel manufacturer said some three years ago: "If they could drill it fast enough we can shovel it; the shovel depends on the drill." Well, it can be drilled; but, strange to say, in this case the drill depends on the shovel.

The drilling cost represents 11 per cent. of the total cost of a cart load; and as block holing is not practiced in this soft material the drill is not of such great assistance to the sorter. If it were possible to cut the drilling cost in half, which would be desirable, it would mean a saving of less than 6 per cent. on the total expenditure.

An accompanying sketch illustrates how well the material lends itself to stripping with mechanical appliances; and the photographs show the amount of handling necessary under the present system in both *rajos*—all of which is another story.

In this section of the Chilean nitrate fields, the day of hand drilling is past; and the question of the cheaper handling of the material on the *pampas* should not be hard to solve, especially if the manufacturers of that class of machinery will study the problem from the proper angle and make the equipment fit the conditions, inasmuch as some conditions cannot be changed to suit the machinery.

| | HAND DRILLING | MACHINE DRILLING |
|---|---|---|
| Feet drilled per man-day | 3.30 | 43.00 |
| Labor cost, per foot...in pesos | 3.60 | .48 |
| Cost of explosives per cart load produced.. " | 4.09 | .77 |
| Total cost drilling and blasting per hole.... " | 65.44 | 25.85 |
| Cart loads produced per hole drilled | 26.85 | 24.08 |
| Cart loads produced per sorter-day | 1.07 | 1.88 |
| *Total cost per cart load...in pesos | 11.63 | 6.92 |

Difference in favor of machine drills 4.71 pesos or 41.3 per cent.

*The above totals were arrived at after omitting detailed figures covering other minor operations, such as depreciation, interest, etc.

*Loading holes with black powder.*

## PROGRESS ON HUDSON RIVER VEHICULAR TUNNEL

THIS GREAT undertaking has now reached a stage where the actual work of driving the tubes under the river is in hand. The first of the shields is being pushed forward from the bottom of the Canal Street shaft on the New York side. The shield was built by the Merchant Shipbuilding Company of Chester, Pa., and has called for the exercise of much care in assuring a nice fit of the associate steel elements. Fully equipped, the shield weighs about 400 tons, and its motive impulse is compressed air. The air for this purpose and for the driving of pneumatic tools of various sorts is supplied by a plant consisting of seven large compressors—two of them being high-pressure and five of them low-pressure machines.

On the New Jersey shore, the powerhouse has been erected and the nine compressors have been delivered but are not yet lined up on their foundations. Two of these machines are for high-pressure service, such as is demanded by air-driven tools, while the seven remaining machines will furnish low-pressure air for the shield work.

Land shaft caissons are under construction for the New Jersey end of the tunnel, and will probably be sunk by the time this Magazine is issued. The lower portion of the river shafts are now being fabricated by the Staten Island Shipbuilding Company, and will be launched and floated into place before the close of the present year—probably sometime in November. These will be sunk as compressed air caissons when once they have been moored over their designated sites.

Piles are now being driven for the foundation of the river shafts on the New Jersey side of the Hudson. There will be two river shafts near the New Jersey shore but only one adjacent to the New York side inasmuch as the two tubes will at that point be taken care of by a single shaft.

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The Royal Netherlands Aeroplane Company completed, on the 22nd of July last, a flying service covering a total distance of 621,370 miles during which passengers, freight, and mail were carried. It is reported that not a single accident occurred. The Company maintains a daily schedule between Amsterdam and Paris and a twice-a-day schedule between Amsterdam and London. The distance over each of the routes is approximately 300 miles.

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Plans have been approved by the Mexican Government for the building of a large generating plant at Tepeji, in the State of Puebla. The plant will develop about 50,000 H.P.

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During 1921, 19,527,200 pounds of sesame seed were produced in Mexico. A fine edible oil is obtained from the seed, and the commodity has many uses.

# Petrograd of To-day

## Graphic Story of a Great City's Progressive Ruin Through Misrule and Neglect

A FORTUNATE turn in the progress of a certain business, the peculiar nature of which readily gained the necessary facilities for the undertaking, occasioned a business trip to Petrograd, and having just returned from the familiar surroundings of former times, I am setting down my impressions while they are still fresh in my memory.

In the days when St. Petersburg was the Imperial Capital of the Tsars of all the Russias, it was without doubt one of the stateliest and most beautiful cities of Europe, but now there is little in evidence to remind one of the vanished pomp and splendor. Gloom has supplanted the pomp, and ruin is supreme where splendor reigned. The blight which has been eating into the very walls of the city has spread to such an extent that no sooner does one enter Soviet Russia from across the Finnish frontier at Bieloostroff, than it seems as if civilization and culture, as we understand them, had remained behind on the other bank of the little river called Bielo, where Finland ends and Russia begins.

The journey from the border traverses a district which, in the old days, was one of St. Petersburg's most fashionable and highly exclusive suburbs. The appearance now presented is the picture of desolation itself. The fine residences and outhouses have been despoiled and the structures torn down for the sake of the firewood that could be carried away. Crumbling foundations and piles of debris are all that are left. It is uncanny, eery, and, one cannot escape the feeling that war has passed here and that battles have raged back and forth across these devastated gardens and parks. Even the train upon which one travels presents a dismal spectacle, being made up in the main of freight cars, very old and decrepit, quite capable of collapsing without warning, and it is painfully evident that the rolling stock has not been inspected or repaired for a very long time.

It is inevitable that the journey should be interrupted frequently; the train is delayed not once, but many times during the course of the short run, which, in better days, required about twenty minutes to cover, as against a matter of several hours at the present time—if fortune favors you.

The general outward appearance of the city does not offer anything more reassuring to the arriving traveler than the preliminary glimpses of the Bolshevik's New Russia. The immediate impression one gets is that the streets and buildings have fallen into evil condition; there are yawning holes in the roadways; the houses are utterly delapidated, and the shop windows are boarded up tight—the outward aspect, at least, suggests a city of the dead.

The following day I went out for a stroll through the city on a sight-seeing tour, so to speak. It was immediately noticeable that the people encountered on the streets no longer have quite the same down-and-out appearance that was so common to all humanity in Russia in 1920. When wearing presentable clothes people are no longer oppressed with the overpowering fear that they will attract notice and bring down upon themselves one of those terrifying nocturnal visitations by the Red Guard that enjoyed great popularity with the communists for a long time, because officially it is now considered that the process of "proletarization" has been completed. While the clothes being worn do not represent the height of fashion, according to Western standards, nevertheless they are not in the ripped and tattered condition that characterized the garments of the "intelligentsia" during the height of the "terror" and what I suppose might be called the practical "distribution of wealth." If the people's clothes are still in fairly decent condition, it must be recognized that they represent the very last reserves, saved up from former years, but footwear is another story. There is ample evidence that the shoe question presents a very distressing problem. The women do not impress one as being entirely immaculate, but to make up for the deficiency in the application of soap and water they resort to a liberal use of powder and cosmetics. Oddly enough it seems as if it is always possible to scrape together the money for this powder even when there is none to be had for soap! Another difficulty the women have been forced to face is the fact that women's stockings simply are not to be had in St. Petersburg. The only thing they can do is to adopt socks and the effect is very original.

It cannot be said that the streets and buildings in the heart of the town show any advantage over those in the outskirts; on every hand rack and ruin, great mud holes and horrible stenches. On the Sadovaya Oulitsa even entire houses have collapsed owing to indifference or lack of attention where necessary repairs were concerned, and the street has been completely blocked by rubble and debris. So far it does not seem to have occurred to anyone that the roadway could be cleared. (The Sadovaya Oulitsa is one of the most important crosstown thoroughfares leading to the Champ de Mars and across the Troitzky Bridge to the fortress of St. Peter and St. Paul).

The outstanding feature of the city's atmosphere is its oppressive and malodorous character. This is impressed upon the traveler in the most positive manner when passing by open cellar windows or house entrances, which have generally been called upon to replace the defunct sewer system. The subsoil around St. Petersburg consists chiefly of rich black mud, decidedly swampy, and as the ground seepage water is no longer kept under control with pumping as in former times, it rises into the cellars and forms a very revolting mess besides creating ideal conditions for natural bacteria culture. Here is where the dread typhus breeds.

Besides being out of operation, the sewer system is in the last stages of decay, continually causing miniature subsidences in the street level. When a heavy vehicle happens to pass over a weakened spot, the roadway caves in, causing carriages and automobiles to abruptly vanish into the underworld. The pavement is not only being weakened by the collapsing trunk sewers, but also by the action of the ground water, which is slowly but constantly washing away the unstable subsoil, and the famous Nevsky Prospekt itself has not escaped the general fate. On this, generally conceded to be, or to have been, the most imposing avenue in Russia, I came across a spot where an automobile had sunk so deeply into an exceptionally large cavity that it was not visible at all until one approached within 30 feet of it.

It is not advisable for the stranger to go prowling about the town after dark, because the

**A LITTLE over a year ago the Magazine published an intimate study of the trend of Soviet rule, entitled, "Actualities in Industrial Russia of To-day." We are now fortunate in being able to print a second article from another equal authoritative source, which plainly shows the inevitable result of the ruinous policies outlined in the former article.**

**It would be an erroneous conclusion were one to assume that the Capital founded by Peter the Great owed its unhappy condition to the fact that it no longer occupies a significant position in the eyes of Russia's rulers. Even though they have removed the Capital to Moscow, there has been ample evidence to prove that they have never ceased to regard the retention of Petrograd as vital to a successful development of the communist state.**

**St. Petersburg has not lost one whit of its former significance. It is still Russia's "window to Europe," but despite the extraordinary efforts put forth to preserve the city it has not been able to hold its own against the forces of nature. The handicap of misrule is too great.**

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*Russian "ricksha" men in front of the famous Winter Palace. With most of the horses slaughtered for food and gasoline prohibitively high for use by taxis, sleds drawn by the poor have replaced the street cars and the droskies of former times.*

sidewalks have caved in at all too frequent intervals. A stranger unfamiliar with these treacherous streets, who unwisely attempts to negotiate them after nightfall without the assistance of an experienced guide, certainly does so at risk of life and limb. Now that street illumination is no longer officially regarded as one of the essential public services for which provision must be made, there is no organized attempt to relieve the utter darkness of the night. Here and there one does, however, come across a makeshift oil lamp, the feeble rays of which, struggling bravely as they may, have only the effect of enhancing the gloom. At one time the nocturnal hold-up business prospered greatly under such conditions as these, but no more. The penalty for highway robbery is death, carried out with gruesome promptitude, and fear of this has caused the gentry, whose proclivities inclined in that direction, to become mightily discouraged. Public safety in so far as violence without official sanction is concerned, is, generally speaking, good.

Public squares, flowerbeds that formerly contributed so much to brighten up the city, and all vacant ground have been rented out to the people as little "Ogorodi," or vegetable plots of the war-garden variety, which are worked by the more industrious inhabitants.

The Nevsky Prospekt, which the Bolsheviki have rechristened "Prospekt of October 25th" (Prospekt signifying avenue or boulevard), notwithstanding the discouraging impediments to vehicles, still has a little traffic upon it. Here and there one may observe a surviving "Izvostchik," who, in spite of the dejected appearance of his poor, old horse, goes about his business with the perseverance typical of the jehu the world over. As might be expected, such shops as there are to be found are on this thoroughfare; they are run by petty shopkeepers who do business with the good old things in the good old way, but not at the good old prices by any means. Here one also finds public restaurants where orchestras play, while they serve the good old dishes in the good old way but at a scale of prices that is entirely new. These restaurant keepers deal in millions, charging alone four million roubles for a bottle of discouragingly bad beer; also they are able to freely offer wines and liquors of great potency, because the Bolsheviki long ago sent prohibition (introduced by Tsar Nicholas II) into the discard. This does not mean that the people are able to imbibe as freely as before the European war, because they find it difficult to replenish the supply of the necessary "Millions" with sufficient speed.

Self respecting Russians, of the type that in other countries would be looked upon as good and desirable citizens, do not find the living problem easy of solution; the highest pay allotted to them is but fifteen million roubles per month, and the average is less. I ran across an old friend of mine, who, when I had last seen him, occupied a responsible position as a director in a large American-owned corporation. Now through dire necessity this Russian gentleman is serving in the Marine Department where he is paid the munificent salary of ten million roubles a month; converted at optimistic rates this might equal two dollars and a half. The amazing part of it all is the fact that he is able to eke out this salary so that it covers his living expenses for an entire week. The ensuing deficit has so far been made up out of the proceeds from the sale of personal effects carefully saved up from former days. Lucky is the man who still has anything left to sell, particularly in the jewelry line, because nowadays an article such as a diamond ring will realize at least three hundred millions. While Russia's money factory continues to run smoothly it will always be possible to find a soldier or a sailor who is "in funds" and willing to buy these trinkets. Let the currency depreciate. Let the factory shut down occasionally due to paper shortage. So long as the supply of notes is kept up, the gentlemen at the receiving end of the factory are perfectly satisfied with things just as they are.

The survivors of the class excoriated by the communists under their favorite appellations "Bourgeoueff" and "Intelligentsia," who have not succeeded in fleeing Russia, are gradually succumbing to the harsh conditions of their precarious existence. They perish from all kinds of epidemics to which their enfeebled physical condition renders them easy prey. By now their treasured stores of personal belongings have been disposed of and they can

Credit, Underwood & Underwood.

*The bread line is a grim reality in Soviet Russia even though the present government would have the outside world believe otherwise.*

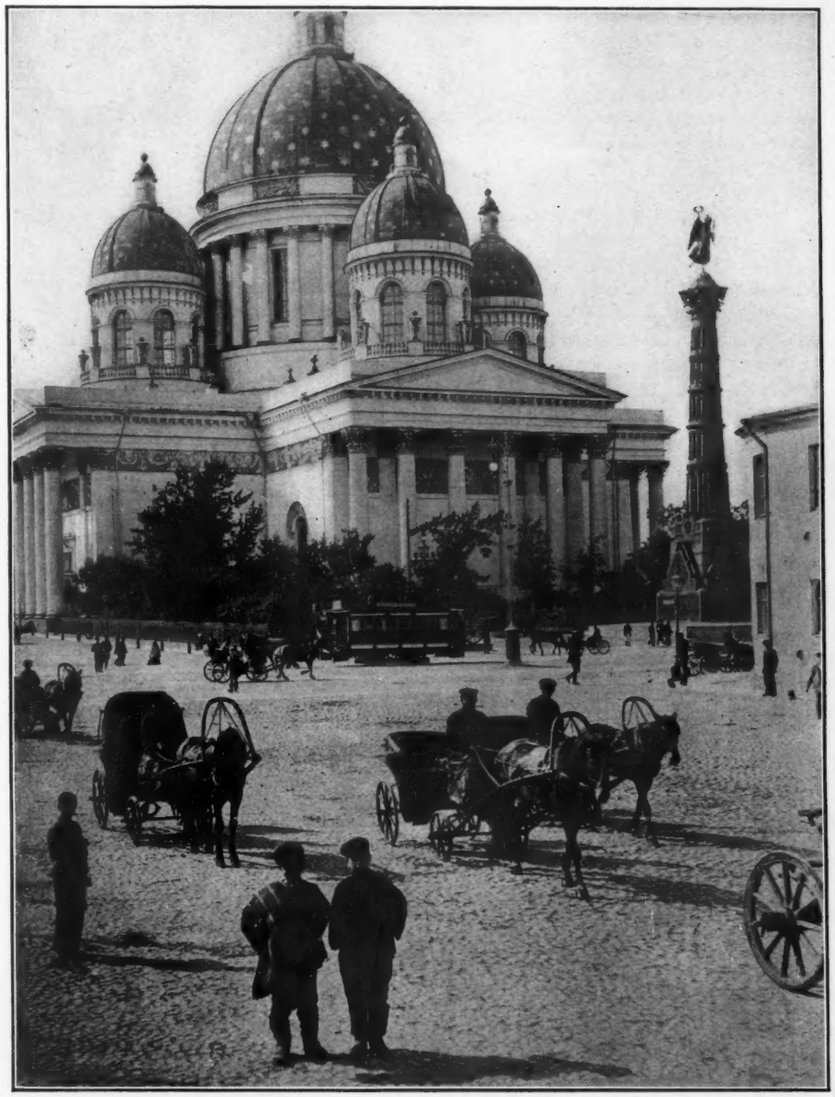
not conjure from anywhere the millions of roubles that are needed to provide regular meals. The high cost of eating of course comes in for its share of attention, and I heard a proletarian comedian provoke mirth by playing upon it. He was appearing in one of the proletarian restaurants, and the substance of his joke was, "What is the difference between a Russian and an American millionaire?" I gathered that the difference lay in the fact that the Russian is able to eat several millions worth, which is an accomplishment for the present beyond the reach of the American—it follows therefore that fundamentally speaking, Russia must be the richest country. Proletarian humor! In spite of the "wealth" extolled by the comedian, an educated man is not able to provide himself with the most elementary luxuries, such as getting a hair cut, which, at a place where vermin are absent, costs three-quarters of a million roubles.

Artificial means are used to bolster up the courage of the population, and the newspapers, of which there are very few, and those published in limited numbers, industriously write up daily the various revolutions that are in progress in Germany, England, and the United States. These genial lies spread broadcast are accepted by the people at large, and any attempt to convince them that the outside world is going along in exactly the opposite manner meets with frank disbelief. The listeners regard you with amazement and in a tone of finality apprise you, "It is written so and so in the newspapers." The way the moujik reasons, the printed word must represent the truth, because who would take the trouble to print a lot of lies?

The time does not appear to have arrived for establishing normal business relations with the Soviet Government, because substantial security is lacking. The absence of customary guarantees has not prevented deals of rather large proportions from being arranged in isolated instances, inasmuch as settlement does not always have to be arranged on a cash or a gold basis. The most common practice is to resort to barter, the Soviet Government tendering in payment furs, valuables and other useful objects requisitioned from private owners in the past. Those who seek trade of this character realize that the merchandise offered them in exchange for their products may turn out to be their own property forcibly expropriated by the Soviets three or four years ago.

The shipping situation in Petrograd is not particularly favorable just now, as it has if anything suffered more severely than the land transport. The wrecks of several ships can be seen in the river Neva, a striking example being the hulk of a mighty vessel lying off the end of the 15th Line, Vassily Ostroff. This steamer formerly served as a transport but it capsized and sank, and all that can now be seen of it are the side of the hull and a part of the bottom which project above the water. So far it has proved impracticable to refloat these wrecks as suitable salvage equipment is not on hand.

Dredging operations have been neglected for several years, and the commercial harbor is in pretty bad shape. Sand bars have silted up in the famous marine canal to a point where passage is blocked to all but the smallest of ships. This means that vessels of medium and large tonnage are unable to reach the commercial harbor at all, and must discharge their cargoes at Kronstadt. At best, the unloading and clearing of vessels are subject to most unusual delays, owing to the general antipathy of the Russian workers towards work, and venturesome shippers who send their steamers into Russian ports inevitably pile up heavy demurrage.



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*The Church of the Holy Trinity on the Ismailoffsky Prospekt, opposite the 3rd Rota, is one of the most striking examples of architecture in the old Capital. The building is white, while the five domes are sky blue, dotted with silver stars and surmounted by gold crosses. The column of cannon and the semicircle of field guns are trophies from the Turkish wars, which liberated the Balkan Slavs. This picture was taken in the days of Petrograd's former glory.*

Today the rabble represents the dominant element of the population, and they have long since lost all vestige of the very thin veneer of decency and self-respect that exercised any restraining influence in their lives. Large numbers of unemployed factory workers pass their time idling along the water front, apparently bent upon avoiding any form of exertion more exacting than occasionally expectorating into the waters of the Neva. An existence of this sort may not be very exciting, but the proletariat seems to feel quite content with it, because he has always been accustomed to live amongst dirt and degradation, and now he is able to enjoy the additional advantage of idleness.

After all the factories around the city had been forced to close, due not only to scarcity of raw material, but also to dwindling demand for their products, compulsory labor was abolished as a matter of course; and it suits the proletariat. He will contrive to exist and enjoy the kind of a life that appeals to him for a while longer, without heed to the morrow, and when he has finally consumed or sold the last of the things accumulated through cheating and stealing, it is his firm conviction that help for him and his class will be forthcoming from the outside world. At the critical time these shiftless wretches will in all probability experience a rude awakening.

Public morale has evidently continued to decline ever since 1917, and the open air con-

certs held regularly in the Letny Sad (Summer Garden) represent one of the isolated attempts to keep up a form of popular activity. A very good symphony orchestra presents the musical program in these gardens, but attendance is made prohibitive to the common people, by the half million rouble admission charge. Only the "better" class (Bolshevistically speaking) can afford to patronize this enjoyable but expensive entertainment. The social elect one meets there consists of Jews and nouveaux riches whose fortunes were amassed while pursuing the profiteering call of the backstairs peddler, and brazenly disposing of illicit wares at highbinder prices. Foreigners, too, are to be seen, Germans constituting a heavy majority.

The Germans in Soviet Russia are arranging things to suit themselves and are very self-important about it. They have an ambassador in St. Petersburg, consuls in various towns, and are founding their own "Vereine" wherever they are. The depreciation of their own currency has enabled the Germans to conclude several deals with Russia, primarily in agricultural equipment. Whether or not this is sound business remains to be seen, because any day the Russians may decide as it suits their fancy to repudiate their large credits and stop payments. The unfortunate merchant will then find himself in a very serious predicament.

The scarcity of most raw materials has been acute for some time, and practically all the factories are idle. Those plants that are still able to secure sufficient supplies to maintain operations are engaged in turning out wares for peasant consumption, and they are badly handicapped by inactive market conditions. The prospective consumers for these products, to wit, the peasants, have been so efficiently plundered and oppressed by the government that they have not the means for spending on even the most necessary articles, and all that is left to them is a tiny strip of land that they work in a primitive fashion of their own, producing barely enough for their immediate personal needs. The peasant has long since learned the fundamental lesson, that a surplus invites requisition.

The situation and psychology of the peasant does not differ widely from that of the urban worker. He is shifting along in an aimless sort of a way, making ends meet with the assistance of the property he was able to accumulate during 1918, 1919 and 1920 by systematic theft and illicit barter with the hard-pressed city dwellers. At the latter he displays great shrewdness and the ethics of a Shylock. Taking all this into consideration, in even the most favorable districts, those which have so far escaped the horrors of prolonged droughts with the sequel of hopeless famine, are just making ends meet, and no surplus is being created against hard times. If famine reaches them in turn, they will be no better off than the peasants have been so far in the stricken provinces. When things go badly, the central government does not bother about organizing relief for the sufferers, and the demoralized peasants of to-day are too indolent and ignorant to devise ways and means of self-help.

*This photograph of a provincial cathedral in Russia, taken about a year ago, shows how the church had been able to keep up its property until that time, even though state support had been cut off.*

They appear to be quite incapable of individual or joint action, and the answer to urging is "God will help us to escape this evil," but it does not seem to occur to those affected that they should contribute a little help themselves.

It is a dark picture, but these conditions of wretchedness will not continue always, and we cannot help looking hopefully forward to the better days that are coming, when life gradually settles down again into the normal course.

## DEEPEST MINES

The deepest mine in the world is that of the St. John Del Rey Mining Co., at Morro Velho, Brazil, 6,426 feet below the surface. The depth is reached through a series of five shafts staggered to follow the pitch of the lode. On the Rand, in South Africa, several shafts are over 5,000 feet deep, and one mine is planning to sink to 7,000 feet. At the Ooregum mine, in India, a depth of 5,400 feet has been reached. In the United States, Tamarock No. 3 shaft, of the Calumet & Hecla Mining Co., is one mile in vertical depth. The Kennedy gold mine, on the Mother Lode in California, has a vertical depth of over 4,000 feet.

South African reports for 1921, now at hand, indicate increased production in the mining industry, particularly in the asbestos mines. The development of these mines is to-day one of the important problems confronting the mining interests of the Union.

A notable plan has been submitted to the governor of the State of Morelos, Mexico, by a foreign concern, for the reconstruction of the sugar industry in that state. The project includes an investment of $1,500,000 in United States currency. This sum is to be increased to $3,000,000 by the agricultural interests of Morelos, and the whole amount is to be utilized for the rebuilding of all of the sugar mills and in effecting a general improvement of the plantations.

## MANCHESTER BOASTS A NOVEL DOCK FOR STORING OIL

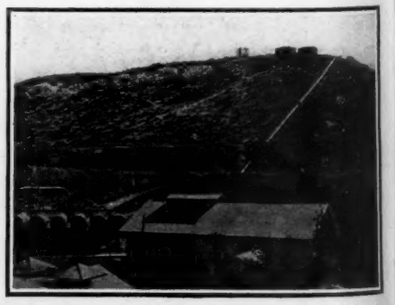
A RECENT issue of *Commerce Reports* describes the facilities for the storage and the discharge of oil at Manchester, England, which have been considerably increased by the opening of a new oil dock at Stanlow, on the Manchester ship canal. This dock, which is especially designed for the discharge of vessels carrying motor, spirit, and other oils giving off an inflammable vapor at less than 73 degrees Fahrenheit, has been constructed at an approximate cost of $1,250,000.

In the past, the importation of spirit oils into Manchester via the ship canal has been prohibited on account of the danger to passing ships. This menace has now been obviated by the building of the new dock, which is set at such an angle to the canal as to place it clear of the waterway. Steamers can now enter and discharge oil of all descriptions with a maximum degree of safety and dispatch.

A unique feature of the dock is the manner in which it is fronted by a reinforced concrete caisson, which serves both to close the entrance to the canal in case of fire as well as to prevent oil escaping into the canal in the event of leakage in the pipe used for the conveyance of oil from the vessels to the tanks. These pipes pass through a subway 30 feet below the bed of the canal, a method which, so it is claimed, marks a decided innovation in canal transportation of oil.

## PLAN TO EQUALIZE AIR PRESSURE

WHEN LARGE quantities of air are used underground, it often happens that there are wide fluctuations in the amount needed at any one time, according to A. W. Allen in *Engineering and Mining Journal Press*. A plan to keep the pressure uniform and to provide additional storage is in use at a plant near Bisbee, Ariz., which is shown in the accompanying illustration. At the top of the hill, which is about 200 feet high, is a reservoir. Into the bottom of this a large pipe is connected, which follows the contour of the hill down to the base, where the air receivers are situated. This pipe acts as an auxiliary receiver. Under conditions of small air reserve it is filled with water. If the amount of air on hand increases, the water is forced up the pipe and into the reservoir. When greater demands are made on the available supply of air, the water falls in the pipe and so keeps the pressure uniform.



*Arrangement of air pressure equalising device.*

## THE ELECTRIFICATION OF FRENCH RAILROADS

AMERICA'S probable part in the engineering reconstruction of battle-scarred Europe should mean much to manufacturers of machinery of all sorts; and the picture accompanying this article gives material evidence of what the United States is doing towards this stupendous undertaking.

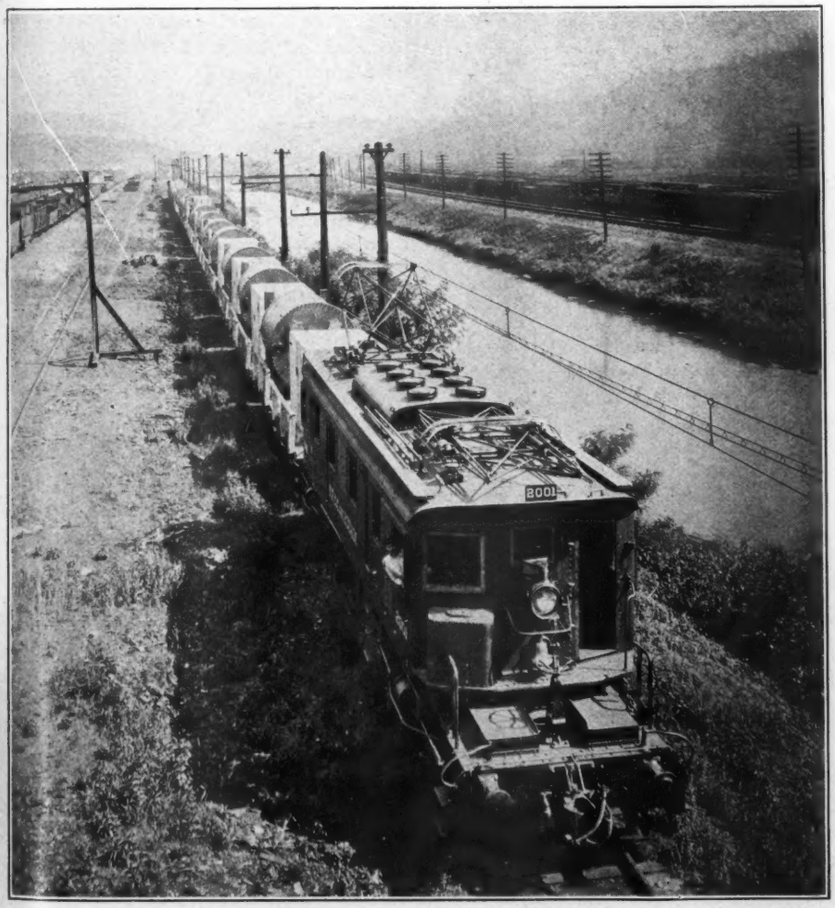
The illustration shows a shipment of transformers and lightning arresters, ordered by the French Midi Railways, valued at more than $1,000,000. The apparatus weighed approximately 800 tons; and 32 cars were required to transport the shipment from East Pittsburgh to New York, en route to Bordeaux. The consignment is of more than ordinary interest because it will enter into the first electrified railway system outside of the United States to adopt 150,000 volts for its main transmission. It is, in short, striking proof of the influence of our engineering practices upon the technical minds of Europe.

The French, early in the war, lost substantially all of their coal fields to the Germans. That, more than anything else, emphasized the need of developing the water-power resources of France and the desirability of electrifying her railroads wherever it could be done economically. Following the cessation of hostilities, one of the earliest acts of the French Government was to send a technical commission abroad to study existing railway systems.

The Commission, after visiting Switzerland, Italy, and the United States, recommended that 1,500 volts, direct current, be adopted as the standard for the electrification of all French railroads; and the Midi Railways Company, in conformity with this decision, immediately resumed on this new basis the work interrupted by the war.

The purpose is to generate power in six stations, or groups of stations, capable of developing ultimately a total of 362,000 horsepower. The head of water varies from 350 feet in the station with the lowest head to a maximum of 2,500 feet. For the initial development, three generating stations will be utilized. The 150,000-volt lines are to connect these plants with the distant cities of Pau, Dax, and Bordeaux to the west, and Toulouse to the east. At the generating stations, 20-000-KVA. banks, made up of Westinghouse single-phase, two-winding transformers, will raise the voltage from 60,000 to 150,000 volts. Conversely, at the sub-stations near these cities, the transmission system connects again with the distribution system through step-down transformer banks of 20,000-KVA., which will lower the voltage from 150,000 to 60,000 volts.

The execution of the various big water-power projects contemplated by France will, of course, call for the use of many of the mechanical facilities commonly relied upon by contractors and construction engineers in prosecuting kindred tasks.



*Thirty-two carloads of electric apparatus leaving East Pittsburgh for shipment to France.*

## THE PROFESSOR ON DODGING RAINDROPS

ONE SUNDAY night recently I made my usual visit to the professor's house. It has been our custom to hold these meetings for the purpose of discussing scientific and philosophical subjects. We always make it a point to study some of the more practical problems, so that the public may benefit by any of our conclusions.

After making the remark that it was a damp night out, I removed my wraps and we headed for the library. This was a quiet, secluded room where momentous problems might be discussed without fear of interruption.

A half hour elapsed before we determined what the subject of the evening was to be; and then fate came to our rescue. We heard the patter of raindrops on the window.

"H'm!" I said, "It looks as if I am in for a soaking on my way home to-night." Then after a pause, "By the way, will I gain anything by running home? You know, it seems as if a person only runs into more drops of rain when he hurries."

This started the ball rolling on the main topic of the evening. The professor drew his chair up close to a table, pushed his tortoise-rimmed glasses further down on his nose, and began to draw diagrams and to make calculations on a piece of paper. He sat there for about two cigarettes, to use my own unit of time. His ears wiggled occasionally, which I always knew was an indication that he was in deep thought.

Finally, he looked up and said: "Young man, you will not get as wet by running as you will by walking. On first thought, one might think that the number of raindrops that would strike you would be proportioned to the time you are out in the rain. But this is not so.

"There are two main points that we have to deal with. One is raindrops falling on a horizontal surface and the other is rain falling on a vertical surface. In our case the top of your head and shoulders represents the horizontal surface and the front of you the vertical surface. To simplify the problem, we will suppose that the raindrops are falling vertically, as is the case when no wind is blowing. We must also assume that the rain is falling uniformly, that is, so many drops per second on a square foot of horizontal surface.

"Now the number of raindrops falling on a given horizontal surface, such as we believe the top of your head and shoulders to be, depends on the time that the surface is exposed to the rain. It makes no difference whether the surface stands still or moves. By moving, it gets out from under falling rain in one place only to get under as many drops in another place. The time of exposure is what counts. Hence, you can see that if you run home in five minutes, instead of walking home in ten, you will get only half as much rain on your head and shoulders.

"But a vertical surface is a different matter. Suppose that you are two feet wide and six feet tall. This would give you a frontal vertical surface of twelve square feet. Assume that you are going a distance of 1,000 feet in the rain. The space

that you then travel through amounts to 12,000 cubic feet. You must imagine that you cut a channel through the rain two feet wide, six feet high and 1,000 feet long. At any one instant there are a certain number of raindrops in this channel, 1,000,000 say. It is true that the same drops that are there one instant are not there the next. But those that hit the ground are immediately replaced by new ones falling from above. We can, therefore, safely assume that these raindrops in our channel of 12,000 cubic feet are standing still in space. It is plain, then, that your frontal surface will meet with the whole 1,000,000 drops regardless of whether you hurry or take your time. You cannot avoid a drop by running. Speed is not a factor here.

"To sum up the analysis, when a person goes from one point to another through a uniform rainfall with the drops coming down vertically, the amount of rain that falls on the top of his head and shoulders depends directly on the time he takes to go the distance, whereas the amount that strikes the front of him is a fixed quantity which he cannot lessen no matter how quickly he covers the stretch.

At this point I cut in with the suggestion that by crouching low a person could reduce his frontal area and so avoid some of the rain. I also said that the number of raindrops per cubic foot must be less near the ground than higher up, because the drops gained in speed as they approached the earth and hence must be farther apart near the earth.

"You would not gain much by crouching," the professor replied. "Crouching would increase your top surface. And I doubt very much whether the drops are farther apart, say, two feet over the ground than they are six feet above. You know the air is more dense near the earth than higher up. Therefore, the friction of the raindrops against the air would be greater near the earth. This would tend to counteract any increase in the speed of the falling drops."

It was getting late so I started to leave.

"The best way for me to avoid the raindrops would be to borrow an umbrella, don't you think professor?" I queried as we entered the vestibule.

"Not a bad idea," was his answer.

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The China Trade Corporation is assured the support of the United States Congress, and an act to that effect has been approved by conferees of both houses of the national legislature. The corporation is to be directly under the supervision of the United States Government, and the purpose is to aid in developing markets in China for goods produced in America.

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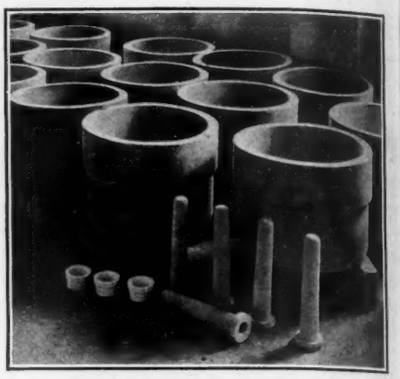
Steel bands are the best protection against the pilferer of freight. It is said that the annual loss from pilferage and from inadequate containers aggregates many millions of dollars. One big concern reports that its shipments are now strapped and that since adopting this system their package troubles, both from damage and pilfering, have decreased 42 per cent. during an interval in which their shipments have increased 20 per cent. in number.

## GLASS POTS FASHIONED MECHANICALLY

NOT ONLY has the optical glass section of the Bureau of Standards, United States Department of Commerce, developed a successful process whereby optical glass can be manufactured in quantity, but it has recently devised a method for speeding up work whereby the element of time is reduced from days to hours. The mechanical fashioning of glass pots from a fluid mixed in a plaster-cast mold, similar to the production of certain kinds of pottery, has made possible this economy of time. Formerly, these pots or containers for optical glass were laboriously built up by hand from a plastic mixture resembling mud.

The pots, each having a capacity of 1,000 pounds, are fashioned one at a time. Contrary to popular belief, these containers are not made of fire-clay but of a mixture resembling procelain. Freedom of the product from iron prevents the pots from taking on a dark hue when subjected to the flames of the fire—in fact, the container is white in color after being burnt. The process of casting glass pots does not involve the use of complicated machinery. As shown in one of the photographs, there is a tank equipped with two agitators, by means of which the mixture is constantly stirred. These agitators are operated by a small electric motor. A hoisting device for lowering and raising the containers is the only other mechanical unit employed.

The miniature, thimble-like glass pots illustrated are used for experimental purposes. They are used in determining the resistance of varying mixtures to the attacks of corrosive glass. Some mixtures dissolve glass readily; the desire being to obtain a mixture least conducive to the dissolution of the glass. The tube-like formations shown alongside the diminutive glass pots are made of the same material as that of the large containers. These refractory tubes



*Glass pots in the process of drying. Note the miniature pots and the refractory tubes, the latter being used in stirring the glass.*

are employed to stir the glass during the process of manufacture. The actual stirring is done by an electrically-operated mechanical stirrer.

The manufacture of this transparent product requires from twenty to 40 hours, depending upon which one of several methods is employed. The finished product is equal if not superior to any optical glass imported from abroad before the war with Germany. There are two manufacturing establishments in the United States producing optical glass in quantity production.

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One of Hankow's leading imports is copper, which is obtained mainly from the United States, and this metal is used principally by the provincial mints in the making of ten and twenty-cash coins. During the war, when the demand for copper was at high tide, the Japanese bought up copper cash, shipped them to Japan, and well-nigh cleared the provinces of central and western China of these coins.

*Showing steps in the process of making glass pots by the casting process.*

# Standard Refrigerator Car Developed for Hauling Perishable Commodities

By S. R. WINTERS

A STANDARD refrigerator car has been developed by the Bureau of Markets of the United States Department of Agriculture and allied Federal agencies entrusted with the problem of transporting fruits, vegetables, dairy products, and kindred perishable commodities from centers of production to points of consumption. The marked improvement in this container over former designs involves the use of heavy insulating fabric. The floor of the car is cushioned with two inches of cork board; the walls and ends are lined with an equally efficient insulating substance of like thickness; and the roof is fortified with 2½ inches of protective "blanketing."

The "U. S. Standard Refrigerator Car," a descriptive term originating with the United States Railroad Administration—a governmental agency which also contributed to its design—is provided with a bunker or chest to hold the ice for refrigerating purposes, thus differing in construction from those of prevailing usage. The box receptacle, with an open bulkhead of conventional design, is displaced by a substantial wire-mesh basket. Free circulation of air all around the mass of ice is the outstanding feature of the modified method of refrigeration. C. W. Mann, pomologist in charge of fruit transportation investigations for the Bureau of Markets, favors the application of the wire basket in preference to the wooden bunker as an ice container. Similarly, an insulated bulkhead, which separates the ice chamber from the loading space, offers advantages not possessed by an insulated, solid bulkhead or a flanged partition.

The refrigerator car is equipped with still another convenience which contributes to its novelty and its efficiency. There is a so-called floor rack, a kind of super-platform, on which perishable commodities are placed for shipment. This framework consists of stringers, 2x4 inches in dimensions, extending lengthwise in the refrigerator car. Specialists of the Bureau, detailed to travel with consignments of fruits and vegetables to study the conditions of refrigeration in actual transit, do not hesitate to recommend this newly designed equipment for hauling perishable commodities. The Pacific Fruit Express has authorized the use of more than 5,000 of these refrigerator cars, which have been standardized by Uncle Sam. The New York Central and Santa Fe railway companies are constructing temperature-controlling equipment closely conforming to the specifications of this type of car.

The development of the system of refrigerating perishable fruits and vegetables while being hauled long distances is a subject that lends itself to an interesting review. The first consignment of perishable fruits, the temperature of which was artificially controlled, was made about 1870. The shipment was subjected to the chilling effect of a mixture of ice and salt, contained in an insulated ice-box. This unpretentious system introduced the term "pony refrigerator," a designation applicable because of the modest equipment employed.

The success of the "pony refrigerator" was acknowledged from the beginning. It was, however, but a single step toward the refrigerator railroad car, as we know it today. The entire body of the freight car is insulated, and tanks are stationed in different portions inside of the vehicle for the storing of ice. The proper location of the ice bunkers at the ends of the car may be considered the third step in the evolution of the temperature-control system. Openings or hatches in the roof of the railway carriage make it possible to supply the bunkers readily with ice. The bunkers vary in design. The Bureau of Markets, in its study of the efficiency of refrigerator cars, has found that the type of bunker is vitally essential to the success of the preserving of fruits and vegetables in transit.

Dr. W. A. Taylor and Dr. G. H. Powell, scientists of the United States Department of Agriculture, have done much to promote the refrigeration of perishable commodities by the use of salt and ice and by mechanical means. The results of their early researches were directly applied to the problem of providing refrigerator equipment for the transportation of fruits and vegetables. The object sought was to ship these products with a maximum of efficiency and with a minimum of loss while in transit. Studies of the essential qualifications entering into the design and the arrangement of refrigerator cars revealed the following desiderata: Adequate insulation, of a suitable and durable quality, to insure a uniformly low temperature under variable influences of heat and cold while the railway train is on its journey. The ice receptacles or bunkers should be so constructed and arranged, and the products so loaded or stowed in the cars, as to permit a liberal and a free circulation of air throughout the cargo.

The office of transportation investigations of the Bureau of Markets, coöperating with railway companies, sent hundreds of fruit and vegetable laden cars across the country in a systematic study of conditions under which perishable products travel from the producer to the consumer. The thickness of insulation, size and form of ice bunkers, and the varying designs of refrigerator cars, came under the observation of these government officials. Like the successful business man who observes, sifts out the unessentials and then applies the useful, the Bureau of Markets has formulated specifications for an efficient refrigeration system. The "U. S. Standard Refrigerator Car" is the result of this series of researches.

Such is the story of the fifty years of progress in regulating the temperature surrounding perishable fruits and vegetables as railway trains speed them afar—grapefruit and oranges, perhaps, from the balmy climate of Florida to the snow-bound areas of New England. The producer with his harvest of plenty, and the consumer with his whetted appetite for an abundance of fresh fruits and vegetables—although these two may be thousands of miles apart—are really next-door neighbors, thanks to the service of the refrigerator car.

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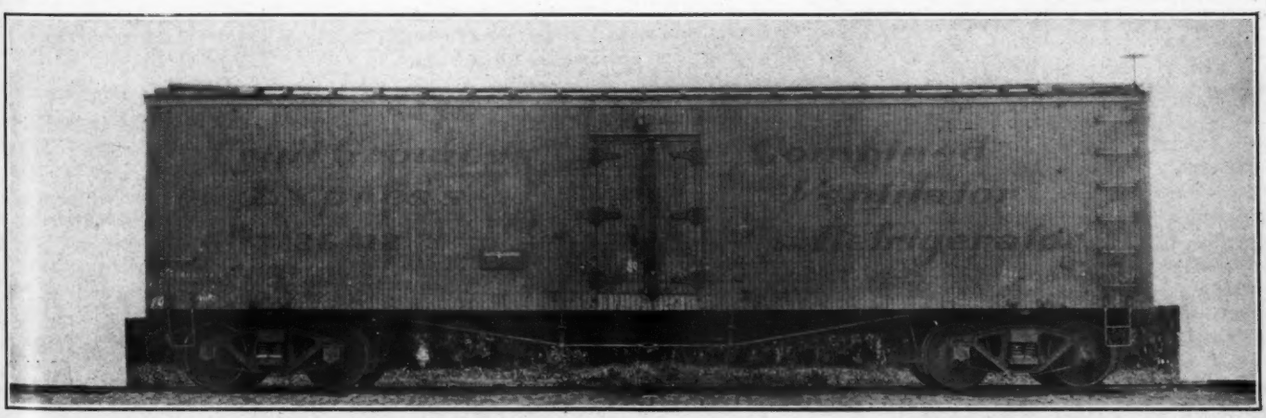
Prosperity is looming at the edge of the industrial horizon, according to Roger W. Babson, of Wellesley Hills, Mass. This eminent statistician said a short while ago: "For the first time in over two years we feel justified in talking optimism. Although it will be a year or more before we can have prosperity, yet we are all justified in preparing for it."



*"U. S. Standard Refrigerator car" developed for the transportation of fruits, vegetables, dairy products, and other perishable commodities.*

# Compressed Air Magazine

—*Founded* 1896—

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*EDITORIALS*

## REASONS FOR THANKSGIVING

TIMES HAVE changed greatly for the better since the days when our New England forebears were moved to offer up thanks for their deliverance from the rigors and some of the perils of that far-off period in our national history. Repeating the practice then instituted, we, too, have now abundant reason to be thankful that the present November has brought us to a turn in the road which promises far easier traveling for us than has been the case in the past twelvemonth.

If progress is to be gaged only by material things, then surely we have ample warrant for thanksgiving; and lest we be disposed to doubt this let us review some of the more outstanding of our blessings.

From our fields and orchards we are garnering crops this year which will represent a total value of $6,600,000,000—foodstuffs enough to provide for our own wants and to leave much in excess which can be sent abroad to less favored peoples. Indeed, our present harvest will fetch at current prices $1,250,000,000 more than that of last season. Herein lies reason for widespread rejoicing.

From no fewer than 200 separate localities reports have been turned in disclosing a steady diminution of idle workers; and in numerous sections of the country there is actually a scarcity of men in comparison with the jobs available. This is one of the best evidences of the speeding up of our industrial life—a change for the better which should hearten all of us.

It has been computed that the strikes among railroad men and miners have entailed a loss amounting fully to $2,000,000,000; but heavy as this tax will be upon the strikers, themselves, and the nation at large, still the adjustment of these industrial disputes puts us that much further along upon the road to ultimate peace and prosperity.

Congress, after months of quibbling and delay, has, at last, passed a tariff bill, and whether or not it is a satisfactory solution of one of our great economic problems, viewed from every standpoint, it does settle many questions and tends to a large extent to stabilize our business relations both at home and abroad.

Finally, our difficulties of the recent past have opened our eyes to a number of the fundamental problems intimately identified with our well-being as a people; we have learned that there must inevitably be a better understanding, closer coöperation among all departments of our social and our industrial lives; and in the realization of these factors, so interwoven with our happiness and our content, there is, indeed, abundant cause for thanksgiving.

## A POSTAL CHIEF ENGINEER

POSTMASTER GENERAL WORK has done a most sensible, a most common-sense thing in the appointment of a chief engineer for the Post Office Department, and he has displayed excellent judgment in the selection of the man for the job. All through the postal service, routine work has to be thoroughly and minutely systematized, and mechanical labor-saving devices are imperative for much of the detail work. No one but an experienced engineer could properly look after these things and maintain their adjustment and efficiency.

Mr. SIDNEY W. FARNSWORTH who has been appointed to the position, was a former aide to Commander McDOWELL, and was on the staff of Admiral SIMS during the war, in which position he was in close contact with the military developments used by the land, the sea, and the air forces. He goes to Washington from the Steel & Tube Company of America, Evanston, Ill.

The appointment of Mr. FARNSWORTH is, on the face of it, a labor-saving and concentrating movement. He will have general supervision especially over the mechanical equipment throughout all branches of the service, and he will examine and pass upon the new devices which are frequently proposed. This work has heretofore been done by committees appointed by the Postmaster General from among the personnel of the various bureaus, and made up largely of men with no special fitness or training and imposing little individual responsibility.

The business of the postal service has doubled in the last ten years while the personnel of the department has increased but 9 per cent., so it is plain that economy rather than extravagance is suggested by the new appointment.

## AIR CHOPPERS ON LONDON PAVEMENTS

THE LONDON people have recently looked with curiosity and interest at the chopping up of old pavements in the busy parts of the city by compressed air hammers. It is not an easy matter to dislodge old and worn asphalt especially so when it has been laid with the care and thoroughness so characteristic of the British. In America one always thinks of the cheapest and quickest way to do a job and there is usually a machine for the purpose. Not so in foreign countries where labor is cheaper and where it is difficult for people to get out of the old rut which has established precedents.

Yet some progressive Britisher in charge of public works has been bold enough to introduce an air compressor on wheels in the streets of London, to fence in a large portion of a busy street, and to repair the pavement in the shortest possible time and at the least expense. He has done this too at a period when the government is paying out millions of dollars to the unemployed. The result of this was that the Hyde Park debaters started an agitation which finally reached Parliament. One of the labor leaders there charged that this work should have been done by hand in order to keep men employed.

This, of course, is one of the fallacies which many labor leaders fall into. It is like the argument that the unemployed should be used to carry blocks of stone to the top of a hill and down again. Labor, when times are good or when they are bad, should only do productive work, and the more productive labor is, that is, the more it produces per man, the greater will be the wealth, the greater the wage scale, the less the unemployed, and the lower the general taxes.

Another point, which the labor leader in Parliament seems to have lost sight of, is that the London streets are the most congested of any in the world. While these improvements are going on it is necessary to divert traffic to narrow lanes, resulting in delays, in economic losses, and, perhaps, in damages. The sooner this is over the better. The air tool does the work quickly and cheaply. In so doing a limited appropriation is extended over a wider area.

## THE HIGHBROW AND HIS BREAKFAST

THE WISE men of medicine have recently made another and not infrequent shift in their professional position. This concerns a no less intimate matter than the amount of food to be eaten at the matutinal repast.

There are hundreds of thousands of us that look upon breakfast as a meal to be hurried through, and the disposition is to satisfy the morning's dietary needs with anything that can be disposed of quickly. In short, the tendency is to give the stomach merely something to quiet it pro tem.

The medical solons now declare, however, that the brainworker must deal more considerately with the stresses upon his gray matter

by partaking of a generous and, incidentally, a leisurely breakfast. This may mean coffee, porridge, rolls, eggs, or some other menu which will furnish enough calories to maintain the necessary pressure in the mental power plant. This may also involve commuting by the 8.10 instead of the 7.25.

Be these alterations whatever they may in the day's routine; admitting that the stomach has all too often been treated badly at breakfast time; nevertheless a menace lurks in this latest dictum of the medicos. Many a man of preëminent mentality will still insist upon making his first meal a light one, while the sluggard and the glutton will be all too ready to indulge himself the more. Highbrow or otherwise, men will still have to be evaluated by the quality and the quantity of their work and not by the amount they eat.

## A NEW PRECIOUS METAL

THE PRECISE date of its arrival may never be determined, and the contemporaneous investigations and experiments which resulted in its ultimate development may have been so distributed that no individual may claim the undivided honor of having discovered it. Nevertheless, there has come to the industrial world within the present century an acquisition of outstanding and enduring value.

Probably none of us appreciate what iron or steel has done for us in the decades past; and it would be idle for us here to talk about it. Yet, curious enough, whatever the magnitude of its status, iron has always carried a serious and, apparently, a hopeless handicap. It has seemed to be doomed to dissipate itself in the course of time, to crumble away through exposure to the atmosphere, and, as a result, there remains to-day only the iron column of Delphi in evidence of the metal's long association with human progress.

Iron and iron rust have been inseparable through all the ages: the latter ruthlessly and completely effacing all traces of the former if not arrested. Rust is ready to begin its work at any moment; and man must fight continually to guard his costly structures, his ingenious machines, his delicate apparatus, etc., from the foe. No animal parasite has so clung to its victim as rust. Iron entirely freed from the menace of rust can only be looked upon as a new metal and, moreover, as the most precious metal of all.

This new metal has come to us without a flourish. Rust, so far as it is concerned, is annihilated. "Stainless steel" is the name given it; but "rustless" might have been the better adjective. It is such a sudden and complete surprise that few as yet have begun to take it seriously. When its qualities are fully realized, and its possibilities are duly weighed, there will undoubtedly be a universal demand for it.

The thin edge of the wedge has been already entered, and the driving of it has begun. Enterprising manufacturers are putting upon the market small knives and larger cutlery made of stainless steel. Knives are shown in shop windows stuck into half a lemon and yet retaining their polish untarnished despite contact with the acid juice. What could be more convincing to the housewife?

With demonstrations of this sort, our more progressive workmen in shops and factories will be demanding rustless steel for their graduated scales, their straightedges, their squares, their calipers, their dividers, etc. This fashion will spread throughout the trades familiar with the older material and reach beyond them into the wider realms of usefulness until stainless steel becomes a commonplace.

## INTELLIGENT ROAD BUILDING

THE ILLINOIS Division of Highways, under the direction of CLIFFORD OLDER, chief highway engineer with the United States Bureau of Public Roads, has recently completed the final series of tests of one of the most extensive experiments on road building ever attempted. The particular location selected for the experiment was a stretch two miles long, divided into 63 sections representing as many different methods and kinds of construction, having various thicknesses of concrete cement grout, and asphalt filled brick, as well as asphaltic concretes, and concrete with rolled stone bases.

After the final tests were completed, the subjection of the road to very heavy truck traffic was commenced. This was applied in the form of a fleet of ten motor trucks. In the beginning the trucks were lightly loaded, and as the test progressed the load was increased until a maximum rear-wheel load of 12,000 pounds was reached.

It is obvious that such an experiment will be most comprehensive and will definitely show comparative results, as well as the minimum requirements of a road to withstand traffic of this kind.

This experiment is the rational development of a number of years of road building, and it may reasonably be expected to indicate the most economic methods of road construction.

## WIDENING THE FIELD OF THE MOVIE FILM

AFTER YEARS of effort, inventors in America and Europe have finally succeeded in endowing the movie film with the capacity to reproduce speech or any other sounds which are purposely associated with the picture at the time of its making.

Like so many other things that arouse wonderment, the talking movie or the acoustic film, call it what one may, is merely an adaptation of principles or facilities already well known, and, withal, rather simple fundamentally.

Dr. LEE DE FOREST, who is taking a conspicuous part in this development, has disclosed how much depends upon the properties of selenium—a metal peculiarly affected in its electro-conductive capacity by delicate gradations in the intensity of light to which it is exposed. In other words, suitably devised selenium cells are the mediums by which the movies are given the power of speech. This achievement is the climax of pioneer work done by ERNST RUHMER, of Berlin, about twenty years ago, when he produced a wireless telephone system which used the beams of a powerful searchlight to transmit vocal waves over a considerable distance.

Other fertile minds have heretofore sought to combine the reproduction of sound with the photo film, but they have failed of success because they could not properly synchronize the sound waves with the light waves. The difficulty can be grasped when it is recalled that sound travels at the rate of but 1,090 feet a second, while light speeds through space at a velocity of 186,000 miles a second. By the perfected instrumentalities, unity between action and speech can now be maintained within a very brief fraction of a second.

According to Doctor DE FOREST, the cycle incident to the making of a film and its display for entertainment consists of the following phases: the conversion of sound waves into electrical waves; transforming electrical waves into light waves; and then recording these light waves on the edge of the film simultaneously with the taking of the picture. By reversing this operation, during the reproduction of the picture, the sound waves are ultimately delivered to an amplifying apparatus which, in connection with loud speakers, serves to project the voice, music, etc., throughout the theater.

As a further climax, technicists, working in another direction, have brought to a finished point a new process by which motion pictures can be colored so as to exhibit the familiar tones and hues of Nature's palette. All of these improvements are bound to increase greatly the interpretive capacity of the movies, to intensify their popular appeal, and to add to their general usefulness in the realms of education and research.

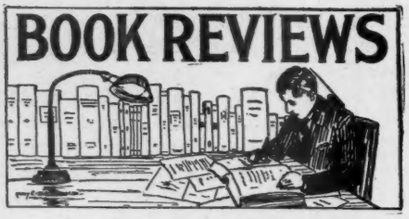
## DID NOAH'S ARK NEVER WEIGH ANCHOR?

THE GENERAL belief that Noah's ark was fashioned of wood, that it was filled with animals, and that that storm-driven craft was eventually beached upon the slopes of Mount Ararat, has recently been dealt a blow by an Egyptologist, Dr. E. C. GETZINGER.

This gentleman, after years of research, declares that the ark is still very much with us, indeed, that it is still intact; after 30,000 years; and, what is equally surprising, he asserts the ark never left the home port, in fact, was never launched for the good and sufficient reason that it could not have moved even if its builders had so wished. This archaeologist says the ark was not an ark, but, instead, the pyramid of Cheops.

Just the same, the structure, like the other Egyptian pyramids, had to battle with the sea for a goodly while, so Doctor GETZINGER claims. In proof of this, he informs us that near the top of each of the pyramids, at the same level, there is a high-water mark where the surf of the far-off ages cut into the stone. And, finally, it seems that a thick incrustation, found upon the inner passages of the pyramids, has been revealed by chemical analysis to be sea salt.

What next of our pet traditions are these prying gentry going to shatter?




THE MEXICAN YEARBOOK, 1920-'21, edited by Robert Glass Cleland, Ph.D. 524 pages, with map. Mexican Yearbook Publishing Company, Los Angeles, Calif.

THE resumption of the publication of the Mexican Yearbook will be welcomed by a large number of people who, for one reason or another, are interested in the Republic to the south of us. The Mexican Yearbook is issued to meet the demand for unbiased and systematized information concerning the country in question. The book, so we are informed, is written expressly for the American public, and has in no wise been inspired, either officially or unofficially by the Mexican Government. This is in contra-distinction to former volumes bearing the same title, which were compiled primarily for English use and claimed some measure of official patronage. These ceased to be printed in 1914.

Numerous competent authorities have contributed to the present work; and everything has been done to make every section of the current issue valuable and helpful to the merchant, the engineer, the statistician, the financier, and the statesman.

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RED CROSS SERIES, in six volumes, at $2 a volume, published by The Macmillan Co., New York City.

THIS GROUP of books tells in an absorbing manner the official story of the part played by the American Red Cross during the World War. Each of the volumes deals with a particular phase of the activities of the great agency of mercy, and has been written by a man familiar with the service and qualified to tell his story in an authoritative fashion. It would be out of the question in the space available to review these books in a fitting way. All of us are more or less acquainted with the work done during those anxious years in our own midst, but this knowledge does not suffice to give us a grasp of what the Red Cross did in Europe close to the theaters of conflict. The records of that work abroad give ample warrant for pride to us as a people and boundless satisfaction to all of us who contributed in any degree to the cause. Every volume is replete with thrilling and heartening history.

The series consists of the following:

The American Red Cross in the Great War. This book by the late Henry P. Davison, chairman of the War Council of the A. R. C., summarizes the work of the thirty million Americans who were enrolled in the organization at the close of the war.

American Red Cross Work Among the French People. Fisher Ames, Jr., deals with a phase of Red Cross work, the scope of which will come as a great surprise to many people.

The Passing Legions. This volume, by George B. Fife, recites the story of the A. R. C. work in England.

The Red Cross in Italy. Charles M. Bakewell gives a vivid and interesting account of the response of the Red Cross to Italy's need during the War.

With the Doughboy in France. The many millions who contributed their mite will be proud to read Edward Hungerford's account of the noble achievements which they helped to make possible.

The Little Corner Never Conquered. In this book John Van Schaick, Jr., tells the story of Red Cross work in Belgium.

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## MINERAL RESOURCES OF ALASKA

THE ABOVE is the title of Bulletin 722 of the United States Geological Survey. Its 266 pages embody a report on the progress of investigations in 1920, and relate chiefly to the mining of gold and copper. During 41 years of mining Alaska has produced minerals to the value of more than $460,000,000, over half of which was produced in the last decade: $19,620,913 in 1919, and $23,303,757 in 1920. The mining conditions and the details of operations are described very completely, also an extensive investigation of the water-power of southeastern Alaska. There is no encouragement for enthusiasm over the coal fields.

A machine has been devised for extracting the pulp from green bananas, out of which flour can be made. Green bananas are generally left to waste on the plantations, but henceforth it is likely that the fruit will be put to a profitable use.

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A flattened strand wire rope seven miles long, without splice in either strand or rope, was recently produced at Birmingham, England. It is 4⅝ inches in diameter and weighs 73 tons. It was shipped in coils on specially prepared and connected railway trucks.

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China, for the most part, is lacking in refrigerating facilities, and, because of this, vast quantities of salt are required for preserving food. The per capita consumption of salt in China averages twelve pounds annually, exclusive of salt used for manufacturing purposes. Crude salt is obtained from sea water along the entire coast line, from brine wells in the extreme western Province of Szechwan, and from the salt lakes in Mongolia. Some rock salt is also taken from the salt mines of Yunnan in the southwest.

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In developing hydro-electric power on the Oswegatchie River in northern New York a wood-stave pipe is being constructed twelve feet in diameter and more than two-thirds of a mile long. The staves are of Douglas brought from the State of Washington. T are 3½ inches thick and are able to tain a head of water of 140 feet.

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For the first time in the history of the Ra says an *African World* cable, the gold out has exceeded one-half of the world's prod tion: the statistics published by the Cham of Mines showing the Transvaal's output be equal to 52½ per cent. of the world's to The Rand production since the commencem of operations aggregates about $3,500,000,

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The beginning of the Dominion of Can was closely coincident with the Centennial the Independence of the United States. E now she has only one-half of 1 per ce of the world's population, 8,593,000.

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Tipping off American business men by rad regarding openings for foreign sales, in ord that our merchants may get the jump on the competitors in the world's markets, is the late trade-promoting stunt instituted by the Unite States Department of Commerce. The "set it-by-air service" is likely to appeal especiall to out-of-town manufacturers and merchan who are not in daily contact with the depar ment's offices in our leading cities.

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The U. S. Geological Survey has disclos that for June of the present year the daily co sumption of electricity throughout the count reached 127,700,000 kilowatt hours, and that t total for the month amounted to 3,831,508,0 kilowatt hours.

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Normally, American leaf tobacco compris fully 80 per cent. of Italy's imports of th commodity. Efforts have been made, und government patronage, to reproduce on Itali soil types of American tobacco, such as t Kentucky, the Maryland, and the Virgin varieties, which for years have been popul with native consumers. These efforts ha been far from successful.

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The cutting and exporting of logwood, f use in the manufacture of dyes, forms one the leading industries of Haiti. The Unit States is the chief customer for this commo ity. It is estimated that in one district alo that of Bahon, there are between 500,000 a 1,000,000 tons of the wood available. One t of wood yields about 500 pounds or one bar of extract.

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Much of the rosin of commerce is used the manufacture of household and laund soap. The next greatest use for rosin is the paper industry.

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The up-to-date sheik is subscribing to conveniences of civilization! It seems he longer depends upon the sun dial or the po tion of Old Sol to mark the passing hou Our consul at Aden reports that Arab chiefta have taken to the wrist watch, and that th show a preference for the type that boasts radium dial.